Prof. G. W. Shaw

Food for Plants

HARRIS AND MYERS

NEW EDITION WITH SUPPLEMENTARY NOTES

EDITED AND PUBLISHED BY
WILLIAM S. MYERS, F. C. S., Director
Nitrate of Soda Propaganda
Late of New Jersey State Agricultural College
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J. C. & W. E.
POWERS
PRESS
N. Y.

FOOD FOR PLANTS.

In part from the writings of Joseph Harris, M. Sc.

Nitrate is a powerful plant tonic and energizer; *it is not a stimulant in any sense of the word;* a very small quantity does a very large amount of work.

We never recommend the use of Nitrate of Soda alone, except at the rate of not more than one hundred (100) pounds to the acre, when it may be used *without* other fertilizers. The phosphate, lime and potash manures should usually be applied in connection with Nitrate of Soda at the rate of about two hundred and fifty (250) pounds to the acre of each. This rate will be found generally profitable for all crops. Nitrate is best applied as a Top-dressing in the spring as soon as vegetation begins to sprout. It will be found quite satisfactory also in its after effect in perceptibly sweetening sour land.

Food Necessary for Plants.

It is well known that animals, and especially young animals, must have all the food they can eat in order to properly develop and grow fat. This is equally true of plants. Plants will manage to live on very little food, but to grow, thrive and bear fruit they likewise require an abundance of food.

The food of plants consists of a number of elements, including Nitrates, phosphates, lime and potash. A sufficient quantity of all these necessary elements, except Nitrates, phosphates and potash, exists in nearly all soils. *Nitrates are nearly always deficient*, phosphates usually, and potash often. In some soils there may be enough of all the elements of plant food except one. This may be assumed to be Nitrate. In this case the growth and yield of the crop will be limited only by the quantity of *Nitrate* it can assimilate. There might be an abundant supply of all the other elements,

Why Nitrate is Indispensable

but plants can never use other kinds of food without Nitrate. Plants must have them *all* to develop in perfection.

Nitrate Nearly Always Deficient. Nitrate (Nitrogen) is the kind that is nearly always deficient. The question that presents itself to the farmer, gardener and fruit grower is, *How can I supply my plants with Nitrogen, phosphoric acid and potash, in the best forms and at the least expense?* We will try to throw some light upon this question in the following pages. We will take first,

Phosphoric Acid. There are three principal sources of phosphoric acid, namely, bones and rock phosphate and Thomas Slag Phosphate. Of these, the rock phosphate is the cheapest source. A prevailing impression exists that superphosphate made from rock phosphate is not as good as that made from bones. It has been shown by many experiments that this idea is entirely without foundation. What the plants want is available phosphoric acid, and it makes little or no difference from what source it is derived.

The largest deposits of rock phosphates exist in South Carolina, Florida and Tennessee. These beds of phosphate are supposed to be composed of the petrified bones and excrements of extinct animals. When this substance is ground and mixed with a sufficient quantity of sulphuric acid, the larger part of the phosphoric acid which it contains becomes soluble in water, and hence available as plant food. This fact was one of the greatest agricultural discoveries of the age.

When the rock phosphate is thus treated with sulphuric acid, it becomes what is commercially known as superphosphate, or acid phosphate. The same is true if ground bone is treated in the same way. Good superphosphate contains 14 per cent. of soluble phosphoric acid.

Potashes. The cheapest sources of potash are muriate of potash and unleached wood ashes, which contain from 3 to 5 per cent. of potash in the form of carbonate. They also contain from 1 to 2½ per cent. of phosphoric acid. They are worth, usually, as plant food, from $7.00 to $11.00 per ton.

Nitrate. Nitrate is the most important and effective element of plant food, and at the same time, as stated, is the one that is generally deficient in the soil.

There are a great many sources of Nitrogen, such as dried fish, cotton-seed meal, dried blood, and tankage. But none of these furnish Nitrogen in the Nitrate form in which it is taken up by plants. This can only be furnished to plants in the form of Nitrate of Soda. Nitrogen applied in any other form must be first converted into Nitrate before it can be used by plants at all.

Nitrate of Soda contains the *Nitrogen* that is necessary for the growth of plants. *Nitrate of Soda* is the best form in which to furnish Nitrogen to plants. When we say the *best* form we mean the best *practical* form. Nitrate of Soda not only furnishes Nitrogen in its most available form, but it furnishes it at a lower price than any other source.

Nitrate of Soda.

Nitrate of Soda is found in vast quantities in Chili. The beds of Nitrate, or "Caliche," as it is called in Chili before it is refined, are several thousand feet above the sea, on a desert plain extending for seventy-five miles north and south, and about twenty miles wide, in a rainless region. The surface of the desert is covered with earth or rock, called "costra," which varies from three to ten or more feet in thickness. Under this is found the "Caliche," or crude Nitrate. The layer of "Caliche" is sometimes eight or ten feet thick, but averages about three feet. This "Caliche" contains on the average about 50 per cent. of pure Nitrate of Soda.

The "Caliche" is refined by boiling in water to dissolve the Nitrate. The hot water is then run off and allowed to cool in tanks, when the Nitrate forms in crystals like common salt. The Nitrate is then placed in bags of about two hundred pounds each and shipped to all parts of the world. Nitrate of Soda, as exported, contains about 15.65 per cent. of Nitrogen, equivalent to 19.00 per cent. of ammonia. How these beds of Nitrate were formed has been the subject of much speculation. The generally accepted theory is, that they were formed by the gradual decomposition and natural manurial fermentation of marine animal and vegetable matter, which contains a considerable amount of Nitrogen.

The same wise Providence that stored up the coal in the mountains of Pennsylvania to furnish fuel for the people of the United States when their supply of wood has become exhausted, preserved this vast quantity of Nitrate of Soda

in the rainless region of Chili, to be used by the people to furnish their crops with the necessary Nitrate when the natural supply in the soil has become deficient.

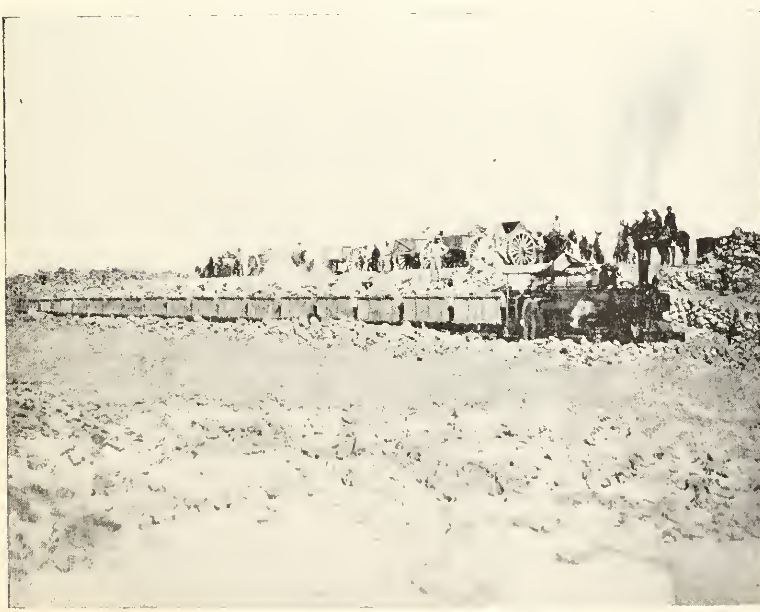
"Complete Fertilizers" and "Phosphates" the Most Expensive Plant Food.

By "complete fertilizers," we mean fertilizers containing Nitrogen, phosphoric acid and potash. These fertilizers are called "phosphates," and people have fallen into the habit of calling any commercial fertilizer a "phosphate," whether it contains phosphate or not. Many so-called "complete fertilizers" are merely low grade acid phosphates with insignificant amounts of the other essential plant foods. *They are unprofitable and ill balanced rations for all crops.*

Bearing in mind that all that is of any value in these "phosphates," *no matter how high sounding their names, is usually mostly phosphoric acid and potash*, let us see what they are really worth—that is, what the same amount of plant food can be bought for in just as good, if not better, forms.

The New Jersey Experiment Station analyzed 195 different samples of brands of "Complete Fertilizers," and published the results in a Bulletin. It was found that, in some instances, complete fertilizers that sold for $34.00 to $36.00 per ton only contained plant food worth $15.00 to $17.00. But they were not all as bad as this. The *average* of all brands analyzed was as follows: They contained 2.74 per cent. Nitrogen, 7.70 per cent. available phosphoric acid, and 4.50 per cent. potash. The selling price was $34.23 per ton and the actual agricultural value $25.66 per ton. By this is meant that the same amount of actual plant food that is contained in the "complete fertilizers," costing $34.23, could be purchased in the open market, in just as good forms, for $25.66. As a matter of fact, it could be purchased for much less than this in quantities of ten tons or more. In one ton of the above "average fertilizer," selling for $34.23, there is 154 pounds available phosphoric acid, which can be bought for $5\frac{1}{4}$ cents per pound in superphosphate or "acid phosphate," as it is called by the trade. This 154 pounds of phosphoric acid is therefore worth $8.09. There is $54\frac{4}{5}$ pounds Nitrogen, which can be bought in Nitrate of Soda for 15 cents per pound, making it worth $8.22; 90 pounds potash, worth $4\frac{1}{2}$ cents per pound, equals $4.05, making in all $20.36 for the plant food contained in a ton costing $34.23.

Opening up Trench After Blasting, Showing Extraction of Caliche by Piece Work.



Loading Caliche into Railway Trucks.

But this does not tell the whole story. The Nitrogen contained in these "complete fertilizers" is often in a form that is neither available nor useful to the plants until it has become converted into Nitrate. The time required to do this varies from a few days to a few years, according to the temperature of the soil and the kind and condition of the material used. In calculating the value of complete fertilizers, Nitrogen in the form of sulphate of ammonia, which has to be converted into Nitrate before it is available, is reckoned at two cents per pound higher than it can be bought in the form of Nitrate of Soda. *This is not because the Nitrogen in sulphate of ammonia is any better than in Nitrate of Soda, but because it costs more in the market. This makes the fertilizers appear to be worth more than they really are.* But taking the figures as they are given, it is readily seen that the consumer of these "complete fertilizers" pays on the average $8.57 per ton more than would buy the same amount of food in as good, and, in the case of Nitrogen, the most expensive form of plant foods, better in unmixed chemicals.

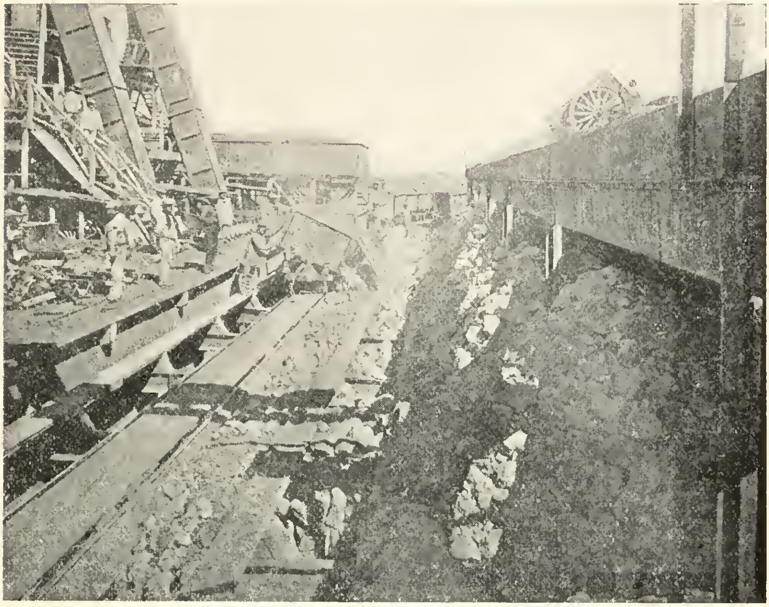
Statistics gathered by the Station show that over *one and a half million dollars* is spent annually in the State of New Jersey alone, for "complete fertilizers." Considering that the average "complete fertilizer" costs 25 per cent. more than it is worth, it is evident that the farmers of New Jersey alone paid $375,000 more for their fertilizers than they got value in return. And this state of things is not confined to New Jersey. It is the same all over the country. The farmers of this country are paying out millions of dollars annually to the manufacturers of "complete fertilizers," which they could very easily save by the exercise of a little care and foresight.

How to Save Money on Fertilizers.

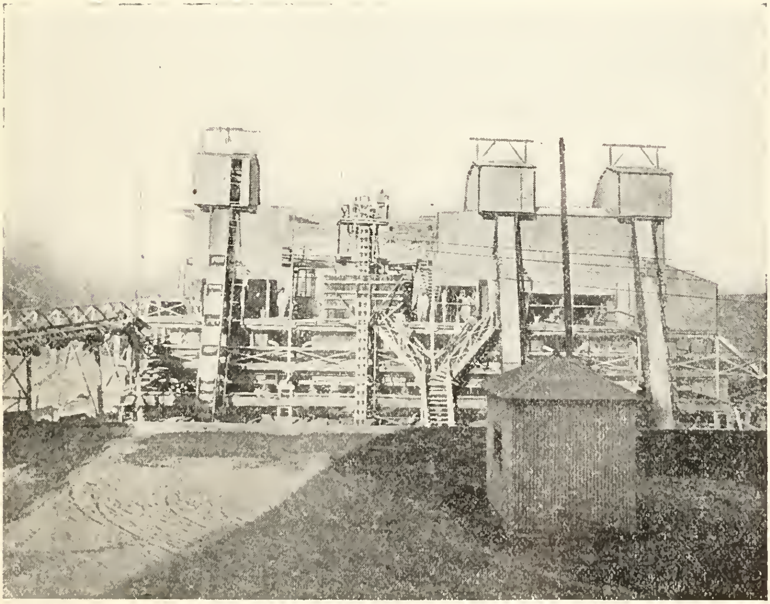
Would you not think a man very unwise who should buy somebody's "Complete Prepared Food," at a high price, when he wanted feed for his horses, instead of going into the market and buying corn, oats and hay, at market prices?

The "Complete Prepared Food" would probably be composed of corn, oats and hay mixed together, and the price would be, perhaps, twice as much as the corn, oats and hay would cost separately. It is the same with plant food.

VIEWS OF CHILEAN NITRATE WORKS.



Top of Caliche Hopper: Carts Tipping Caliche.



Elevators from Crushers to Boiling-Tanks.

You should buy your plant food in the best and cheapest forms, and feed it to the plants as they require it. You can buy available Nitrogen in Nitrate of Soda for about 15 cents per pound. In so-called "complete fertilizers," Nitrogen costs from 20 to 30 cents per pound, and even then only part of it is likely to be available. *Nitrate of Soda is the cheapest and best form in which to buy Available Nitrogen.*

One would not think of buying raw, unground phosphate rock for phosphatic plant food; why, then, should one ever consider seriously buying the most expensive plant food, viz.: Nitrogen in the raw and indigestible forms, which many manufacturers and dealers endeavor to foist on our farmers.

You can buy available phosphoric acid in superphosphate of lime, made from rock phosphate or bone-black, for about 5 to 6 cents per pound (the superphosphate costing from $15.00 to $17.00 per ton, retail). Peruvian guano and Thomas slag also are excellent sources of phosphoric acid.

Potash can be bought, in muriate of potash, for about $4\frac{1}{2}$ cents per pound.

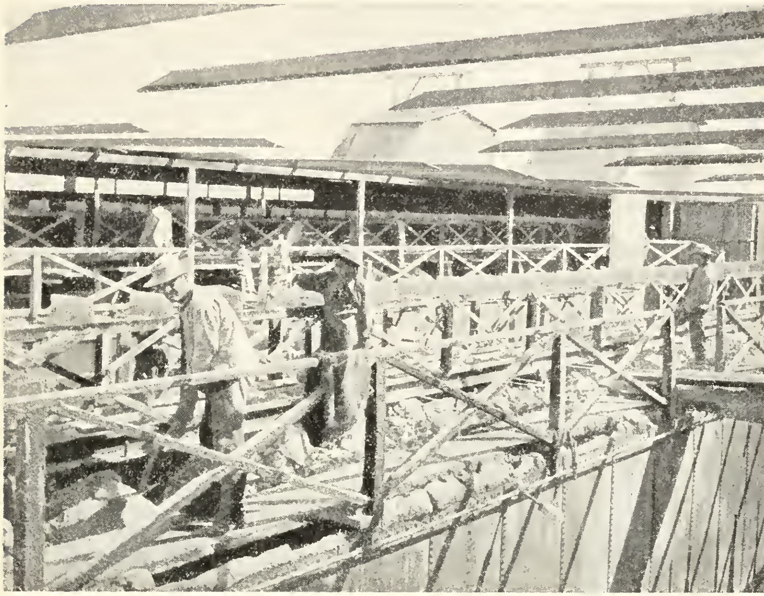
Let us see what a "*High Grade* Complete Fertilizer" made from these three sources of plant food would cost.

600 pounds NITRATE OF SODA, containing 93 pounds Nitrogen, costs..	$14.88
1,100 pounds superphosphate, containing 150 pounds phosphoric acid, costs..........	7.25
300 pounds sulphate of potash, containing 150 pounds potash, costs..	6.75
2,000 pounds, or one ton, costs..........	$28.88

This fertilizer would contain Nitrogen, 5 per cent. (equal to over 6 per cent. of ammonia), phosphoric acid, $7\frac{3}{4}$ per cent., and potash, $7\frac{3}{4}$ per cent.

A "complete fertilizer," containing as high a percentage of Nitrogen, phosphoric acid and potash as the above mixture, would cost at least $35.00, and nine manufacturers out of ten would charge $45.00 for it; and even then the Nitrogen would probably not be in a form in which it would be of much use as plant food until after the harvest.

If a fertilizer is wanted that has as much unavailable Nitrogen as the majority of the so-called "complete fertilizers" sold for $29.00 per ton, it could be made for about $22.00 per ton. *If only unavailable Nitrogen is all that is required by all means plow under a cover crop, and buy only a straight acid phosphate as such.*



Automatic Push-plate Conveyor for Conveying Caliche from Top of Elevators to Deposit over Boiling-Tank.

Crystallizing Pans—Full, Filling, and Empty.

Are the Farmers of Little Europe More Intelligent Than Those of America?

It certainly seems so. The English and European farmers *instead of buying their Nitrogen in complete fertilizers* and paying over 20 cents per pound for it, use annually over eight hundred thousand (800,000) tons of Nitrate of Soda as a fertilizer, while yet only a few thousand American farmers are using it.

American farmers, gardeners and fruit growers are supposed to be ready to "catch on" to a good thing. *And as soon as our Agricultural Papers let them know the facts in regard to the great value of Nitrate of Soda as a Fertilizer our farmers will not be slow to use it.* The reason why so little is said about Nitrate of Soda is simply owing to the fact that there is "no money in it for the trade." It is an article that everybody can sell, and consequently no one can afford to advertise it. *The manufacturers of so-called "complete fertilizers" pay the agricultural papers large sums of money every year for advertising, and consequently the editors do not like to publish anything that might injure this trade.* The real friends of agriculture, however, will be pleased to know that there is a decided increase in the demand for Nitrate of Soda in this country. As soon as the farmers demand it, the importers and dealers in fertilizers will be glad to keep the Nitrate for sale, and sooner or later will advertise it. In the meantime, if your agricultural paper does not tell you about Nitrate of Soda and how to use it, *take a paper that keeps up with the science and practice of the age.*

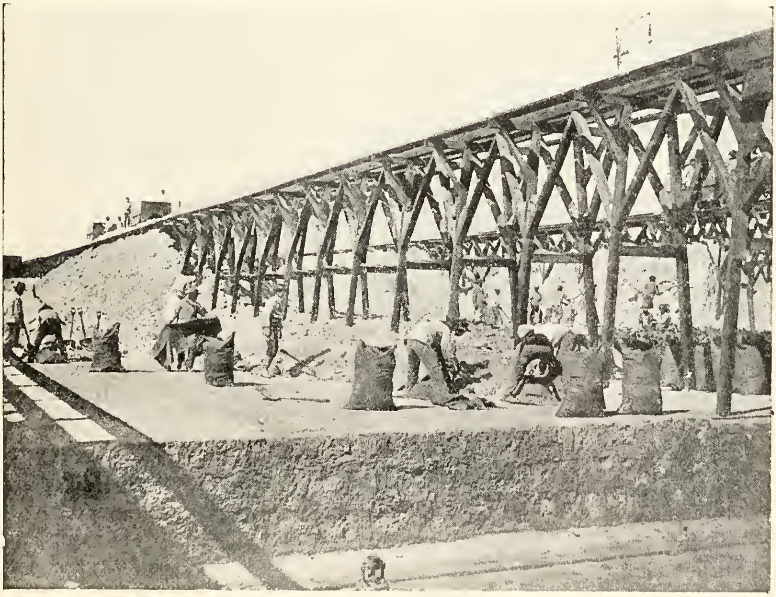
The Best Form of Nitrogen for Wheat.

Some interesting experiments were conducted at the Purdue University Agricultural Experimental Station, at Lafayette, Indiana, to determine the best form of Nitrogen for wheat. We quote the results of the experiments from Bulletin No. 36:

"The forms of Nitrogen selected were Nitrate of Soda, azotine or dried blood, and sulphate of ammonia. The main object was a comparison of Nitrate of Soda with dried blood, and the sulphate of ammonia was introduced into the series for comparative purposes. The forms of Nitrogen used in nearly all commercial fertilizers are dried blood and the Nitrogen of organic compounds like bone meal or cotton-seed meal.

"It is well established that Nitrate of Soda is superior to sulphate of ammonia for wheat, but comparatively little seems to be known of the relative

Crystallizing Pans After Running off Mother-liquor, Showing Deposit of Nitrate Crystals.



Drying-Floors and Bagging of Nitrate.

merits of Nitrate of Soda and organic Nitrogen. The present price of ammonia salts is such that they are not generally used in compounding fertilizers, and it so happens that the Nitrogen of organic compounds is used in the so-called 'ammoniated' fertilizers.

"*Nitrate of Soda gave by far the best results, the gain being nearly double that for the organic Nitrogen, and about one-half more than that for the ammonia compounds.*

"Nitrate of Soda seems to be the controlling factor, so far as the appearance of the plants indicated. The plants on the plots that had received Nitrate were about six inches taller than on those receiving no Nitrate, and this continued until the grain was ripe.

"1. The experiment confirms the superiority of Nitrate of Soda over ammonia salts for wheat, and indicates that its superiority over organic Nitrogen is even greater than that over ammonia salts.

"2. A given sum of money will buy more Nitrogen in the form of Nitrate of Soda than in any other form except cotton-seed, *yet the gain from Nitrate of Soda is nearly double that from the use of organic Nitrogen.*"

Professor Atwater, in writing of some experiments made by Professor McBride, at the South Carolina Agricultural Experiment Station, on Oats and Wheat, says:

"A comparison of four of the tests conducted on both farms indicates that the inorganic Nitrogen (Nitrate of Soda) gave nearly 100 per cent. more increase of yield than the organic (*cotton-seed meal, dried blood, etc.*), and nearly 50 per cent. more than both forms used together."

How to Apply Nitrate of Soda to Wheat.

Drill in with the wheat in the fall a mixture of 250 pounds of phosphate and 50 pounds Nitrate of Soda per acre. If your land is sandy, add 50 pounds of sulphate of potash to the above. Early in the spring, sow broadcast 100 pounds Nitrate of Soda per acre.

Land sown to Wheat in the fall and seeded down with timothy and clover giving a heavy crop, followed by a heavy hay crop the following year, proved the beneficial after effect of the Nitrate; that the Nitrate had not leached away as so many critics claim, and also, that the soil had not been exhausted.

Professor Massey writes in regard to the effect of Nitrate of Soda on Wheat, as follows:

"I have made several experiments with Nitrate of Soda. The first was on wheat in Albemarle County, Va. I used 200 pounds per acre on part of the field which had been fertilized with 400 pounds acid phosphate in the fall. The result was 9 bushels per acre more than on the rest of the field, and a stand of clover, while none of any account stood on the rest of the field."

Two hundred pounds of ammonia salts contain as much Nitrogen as the 275 pounds Nitrate of Soda, but the Nitate produces nearly four bushels more barley per acre. *It is evident that barley must have Nitrate and that it is more effective than any Sulphate of Ammonia, dried blood or cotton-seed meal.*

We would recommend drilling in with the Barley or Oats a mixture of 250 pounds Peruvian guano and 100 pounds Nitrate of Soda per acre, and if the land is very sandy add 100 pounds sulphate of potash to the mixture.

Barley and Oats.

NITRATE TEST

At Kentucky Experiment Station.

BULLETIN 99.

The Oats in this experiment were sown in April and harvested in July. Plot No. 1 was one acre in area; the others were one-half acre each.

No fertilizer, yield, 27.5 bushels.

160 Nitrate of Soda, yield, 37.1 bushels.

A Private Experimenter obtained results as below:

1. 400 pounds superphosphate and 300 pounds sulphate of potash..............................245 bushels per acre.
2. Same as plot 1 with the addition of 200 pounds of Nitrate of Soda..............................348 bushels per acre.

It is evident from the fact that the addition of 200 pounds of Nitrate of Soda produced 103 bushels more than the superphosphate and potash alone, that potatoes must have Nitrogen, and that in greater quantities than is supplied by the ordinary so-called "Complete Potato Manure."

The New Jersey Experiment Station made some experiments in Gloucester County, and the following table shows the results:

Experiments with Fertilizers on Sweet Potatoes.

Kind of fertilizer and quantity per acre.	Cost of fertilizer.	Bushels per acre. Large.	Small.	Total.
1. No manure		157	51	208
2. 320 lbs. bone-black, 160 lbs. muriate of potash	$7.70	205	36	241
3. 200 lbs. Nitrate of Soda, 320 lbs. bone-black, 160 lbs. muriate of potash	12.34	270	58	328
4. 20 tons stable manure	30.00	263	61	324

It will be seen that the addition of Nitrate of Soda to the bone-black and potash gave an increase of 65 bushels per acre, and that the Nitrate, bone-black and potash, together costing $12.34, produced a little larger yield than 20 tons of manure, costing $30.00.

"Another point of considerable importance, since it has reference to the salability of the potatoes, was noticed at the time of digging, viz.: *That those grown with chemical manures alone were bright and smooth of skin, while at least one-third of those grown with barn-yard manure were rough and partially covered with scurf.*"

Tobacco.

At the Kentucky Experiment Station, experiments were made with fertilizers on Burley Tobacco. The land was "deficient in natural drainage," so that the fertilizers could hardly be expected to have their full effect. Yet, as will be seen by the following table, the profits from the use of the fertilizers were enormous:

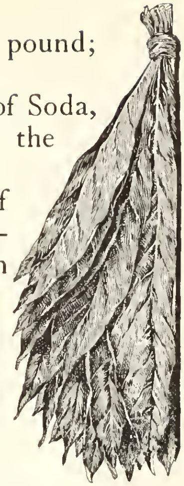
Experiments on Tobacco at the Kentucky Experiment Station.

Fertilizer per acre.	Yield of tobacco—pounds. Bright.	Red.	Lugs.	Tips.	Trash.	Total.	Value of tobacco per acre.
1. No manure		200	360	60	540	1160	$67.20
2. 160 lbs. **Nitrate of Soda**	230	450	310	90	530	1610	138.40
3. 160 lbs. sulp. of potash; 160 lbs. **Nitrate of Soda**	190	755	605	120	140	1810	190.45
4. 320 lbs. superphosphate; 160 lbs. sulp. of potash; 160 lbs. **Nitrate of Soda**	310	810	420	10	360	2000	201.20

The tobacco was assorted by an expert and the prices given as follows: Bright and red, fifteen cents per pound;

lugs, six cents per pound; tips, eight cents per pound; trash, two cents per pound.

One hundred and sixty pounds Nitrate of Soda, costing about $3.75, increased the value of the crop $71.20 per acre!



Nitrate of Soda for Forage Crops.

We recommend for tobacco a mixture of 200 pounds Nitrate of Soda, 300 pounds superphosphate and 200 pounds sulphate of potash per acre. This mixture would cost about $28.00 per ton and would contain over 6 per cent. of Nitrogen (equal to nearly 8 per cent. of ammonia). This is nearly twice as much Nitrogen as would be obtained in a "complete fertilizer" or "special tobacco manure," costing $35.00 per ton.

Milkmen, who sell milk in our cities, know the great inconvenience and loss arising from a failure of green fodder from drouth.

It is now known that the Nitrogen in organic matter of soil or manure is slowly converted into the Nitrate form by a minute organism. This cannot grow if the soil be too cold, or too wet, or too dry, or in a sour soil. As a general rule, soils must be kept sweet and the other conditions necessary for the conversion of the Nitrogen into the Nitrate form are warm weather and a moist soil in good physical condition.

In the early spring the soil is too wet and too cold for the change to take place. We must wait for warm weather. *But the gardener does not want to wait.* He makes his profits largely on his *early* crops. Guided only by experience and tradition, he fills his land with manure, and even then he gets only a moderate crop the first year. He puts on 75 tons more manure the next year, and gets a better crop. And he may continue putting on manure till the soil is as rich in Nitrogen as the manure itself, and even then he must keep on manuring or he fails to get a good *early* crop. Why? The Nitrogen of the soil, or of roots of plants, or dung, is retained in the soil in a comparatively inert condition. There is little or no loss. But when it is slowly converted into Nitrate during warm weather, the plants take it up and grow rapidly.

How, then, is the market gardener to get the Nitrate absolutely necessary for the growth of his early plants? He

may get it, as before stated, from an excessive and continuous use of stable manure, *but even then he fails to get it in sufficient quantity.*

One thousand pounds of Nitrate of Soda will furnish more Nitrogen to the plants *early in the spring* than the gardener can get from 100 tons of well-rotted stable manure. The stable manure may help furnish Nitrate for his later crops, but for his early crops the gardener who fails to use Nitrate of Soda is blind to his own interests.

Tomatoes.

It has been found by experiments made at the New Jersey Experiment Station for a period of three years, that Nitrate of Soda, applied when the plants are set out, greatly increased their growth early in the season and produced a much larger crop of early ripe fruit than either barn-yard manure, "phosphates," or no manure at all.

Experiments with Fertilizers on Tomatoes.

Kind of fertilizer used and quantity per acre.	Cost of fertilizer.	Yield per acre in bushels.	Value of crop.
1. No manure........................		613	$208.61
2. 160 lbs. Nitrate of Soda............	$4.00	838	300.64
3. 160 lbs. muriate of potash, 320 lbs. bone-black......................	7.20	649	252.92
4. 160 lbs. Nitrate of Soda, 160 lbs. muriate of potash, 300 lbs. bone-black	11.20	867	301.25
5. 20 tons barn-yard manure..........	30.00	612	218.27

It will be noticed that 160 pounds of Nitrate of Soda, costing $4.00, made an increase in the value of the crop of $92.03 per acre over the unfertilized land, and $82.37 over the land where 20 tons of barn-yard manure, costing $30.00, was used. It will also be noticed that the addition of phosphate (bone-black) and potash had little or no effect. This does not indicate that tomatoes do not require phosphoric acid and potash, but that enough of these elements of plant food was already in the soil.

"The yield of early tomatoes was very decidedly increased by the use of Nitrate of Soda, both alone and together with phosphoric acid and potash."

Professor W. W. Massey, of the North Carolina Experiment Station, writes as follows:

"In the spring of 1888 I top-dressed an old strawberry bed, in its fifth year of bearing, with 300 pounds of Nitrate of Soda per acre. I had intended to plow it up the previous summer, but other matters prevented, and the bed was in an exhausted condition and rather foul with white clover and sorrel. The effect was amazing, for this bed of an acre and a quarter, from which I expected hardly anything, gave me 7,000 quarts of berries: Variety Crescent with fertilizing rows of Wilson, Sharpless and others. The crop was nearly as large as the best plot had made."

Asparagus.

Enormous profits may be derived from the proper use of fertilizers on asparagus.

If the rent, labor, etc., for a crop of asparagus is $200 per acre, and the crop is three tons of green shoots at $100 per ton, on the farm, the profit is $100 per acre. If we get six tons at $100 per ton, the profit, less the extra cost of labor and manure, is $400 per acre.

In such crops as asparagus, however, doubling the yield by the use of Nitrate of Soda does not tell half the story.

Asparagus is sold by the bunch, weighing about 2½ pounds. The prices range, according to earliness and quality, from 10 cents to 25 cents per bunch at wholesale, or from $80 to $200 per ton.

By leaving out all these considerations and assuming that the non-Nitrated asparagus yields three tons per acre and sells for $100 per ton, and that the Nitrated asparagus yields six tons per acre and sells for $200 per ton, the profits of the two crops, less the extra cost for labor and manure, are as follows:

Without Nitrate of Soda....................	$ 100 per acre.
With Nitrate of Soda......................	1,000 per acre.

How to Mix and Apply Nitrate of Soda and Other Fertilizers.

The first thing to do is to prepare the fertilizers, and if they are all to be used at the same time, mix them together.

Nitrate of Soda comes from South America in 224-pound bags, and is usually thus sold. The Nitrate looks much like coarse salt. The lumps should be broken, which can easily be done by turning the Nitrate out on the barn floor and breaking with the back of a spade. The Nitrate should then be run through a sieve with a mesh not larger than one-fourth inch. It will then be ready for use.

Potash Salts come from Germany in bags weighing 224 pounds each. When lumpy they should be broken as above directed. If the fertilizers are to be mixed together, pour the right quantity of each in a pile on the floor and turn them over two or three times with a shovel until they are thoroughly mixed. It is a good plan to run the whole through a sieve, which will completely mix the fertilizers. The mixing should not be done more than a week before the fertilizers are to be used, as the mixture may attract moisture and get hard if left too long after mixing. In Europe small hand

One Hundred Bushels of Ears of Corn per Acre.
Before Harvesting.

machines are used by farmers for grinding and mixing, and cost about twenty-five dollars. It is also in use in America.

Potatoes. How to Apply. If in rows marked only one way, scatter a mixture of, say, 200 pounds Nitrate, 350 pounds superphosphate and 100 pounds sulphate of potash along the rows, a handful to every step. If in thus walking you step three feet, this will put on about 600 pounds per acre; if only two feet, 900 pounds per acre. Run a fine tooth cultivator along the rows to mix the fertilzers with the soil. It will, of course, be necessary to mark out the rows again before planting the potatoes. If planted n hills marked both ways, drop a handful on each hill and mix well with a hoe.

Apply the same mixture as recommended for potatoes

30 Bushels of Ears per Acre. Fertilized with 10 Tons of Stable Manure and 200 Pounds fine-ground Bone.

100 Bushels of Ears per Acre. Fertilized with 200 Pounds Nitrate, 200 Pounds Sulphate of Potash, 1,000 Pounds Thomas Phosphate Powder.

and in the same way. It usually will not pay to use more than one ounce, or about one-half handful to a hill.

Corn, Cabbages and Cauliflower. For growing cabbages and cauliflower sow broadcast the same mixture as recommended for potatoes, using a small handful to each square yard of ground, and rake or harrow it in before sowing the seed.

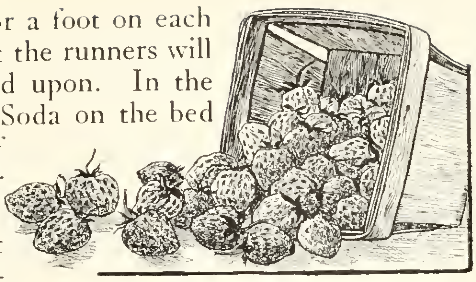
For early cabbage set close together; it will pay to sow the fertilizers broadcast over the whole ground and work them in before setting out the plants. *If the land has been heavily manured for a number of years Nitrate of Soda alone may do as much good as the mixture.* In this case, the Nitrate may be used after the plants are set out—a teaspoonful to a plant.

For late cabbage, set 2½ to 3 feet apart each way. It is a good plan to apply the fertilizers after the plants are set out. To do this, scatter a small handful of the mixture recommended for potatoes near, but not on, each plant. Cultivate this in with a small tooth cultivator. It is best to go twice on each row, dropping the fertilizer on both sides of the plants, using half the quantity on each side.

Celery. Phosphate should be worked into the land intended for growing celery plants, either the fall before or in the spring, before the seed is sown, at the rate of 500 pounds per acre. As soon as the plants come up, sow broadcast 500 pounds Nitrate of Soda per acre, or a small handful to each square yard. If heavy rains occur, it is well to give the plants another application of Nitrate. This need not be as heavy as the first application.

Market Garden Crops. For garden crops such as beets, carrots, parsnips, onions, spinach, lettuce, etc., sow the mixture as recommended for potatoes, broadcast before the seed is sown, at the rate of from 500 to 1,000 pounds per acre, according to the richness of the land. When the land has been heavily manured for a number of years, it may not be necessary to use so much Phosphate and potash. *Nitrate of Soda alone on such land often has a wonderful effect.*

Strawberries. In setting out a new bed, scatter along the rows and cultivate in, before the plants are set out, the same mixture as for potatoes. It is well to



scatter the fertilizers for a foot on each side of the rows so that the runners will have something to feed upon. In the spring sow Nitrate of Soda on the bed broadcast at the rate of about 200 pounds per acre. On old beds sow the mixture broadcast *in the fall* and an additional 200 pounds of Nitrate per acre in the spring.

Raspberries, Currants, Gooseberries.

Sow broadcast, in the fall, a mixture of, say, 350 pounds of superphosphate and 100 pounds muriate of potash per acre. This can be done, if the rows are six feet apart, by sowing a large handful at every two steps *on each side of the row.* Raspberries and Gooseberries should have a small handful, and currants a large handful to each bush. This should be cultivated in, if possible, early in the spring. Sow Nitrate of Soda in the same way. It will pay to put on as much Nitrate as you did superphosphate and potash, but if you do not want to put on so much, use smaller handfuls. If the superphosphate and potash have not been applied in the fall, sow the mixture in the spring at the same time the Nitrate is sown and cultivate it in, early.

How and Where to Buy Fertilizing Materials.

Since Nitrate of Soda and muriate of potash are brought to this country by sea, and phosphate is usually transported from the mines in vessels, *all these materials, as a rule, can be purchased at the seaports cheaper than in the interior.* New York is the largest market for these materials, but Philadelphia, Baltimore, Charleston, Mobile, New Orleans and San Francisco are also ports of entry.

Lower prices can be obtained by buying fertilizing materials in car-load lots. A car-load is not less than ten tons. *If you cannot use a car-load yourself, get your neighbors to join with you.* From $2.00 to $4.00 per ton can often be saved in this way.

In buying Phosphates always consider the percentage of *available phosphoric acid.* You should not pay more than 5 cents per pound for the phosphoric acid. That is, if the

superphosphate analyzes 14 per cent. of available phosphoric acid, a ton would contain 280 pounds, and should not cost more than $14.00 per ton. Thomas Phosphate Powder is also an important Phosphatic Plant Food.

The various "brands" of fertilizers are composed, for the most part, of substances such as plaster, fillers, superphosphate, etc., which can be manufactured for much less than the prices charged for these substances in so-called "complete fertilizers."

Special Crops.

Applying Fertilizers for Potatoes.

The land is first marked and a furrower run along the rows, making a furrow about four inches deep. In this furrow the fertilizer is applied, either by hand, or with a distributor, and well mixed with the soil. This is best done by running a cultivator along the row; or when a distributor is used, an attachment in the form of a small cultivator can be made to do the work at one operation. The potatoes are then dropped in the furrow and covered. If it is thought best to cultivate both ways, the land can be marked across the furrows after the fertilizer is applied.

On What Crops Nitrate Should be Used.

Theoretically, a given quantity of Nitrate will produce a given amount of plant substance. A ton of Wheat, Straw and grain together contain about 1,500 pounds of dry matter, of which 25 pounds is Nitrogen. To produce a ton of wheat and straw together would require, therefore, 170 pounds of Nitrate of Soda, in which quantity there is 25 pounds of Nitrogen.

A ton of cabbage, on the other hand, contains about $4\frac{1}{2}$ pounds of Nitrogen. To produce a ton of cabbage, therefore, would require 28 pounds of Nitrate of Soda.

The most important money crops are beets, carrots, cabbage, cauliflower, celery, onions, tomatoes, potatoes and other vegetables and fruits. The most *profitable* are tobacco, grain, cotton, grass and alfalfa.

There are no crops on which it is more profitable to use fertilizers than on vegetables and small fruits, provided they

are used rightly. Many failures with chemical fertilizers are caused by lack of knowledge. Stable manure, when used in sufficient quantities, almost invariably produces good results, while the unintelligent use of chemical fertilizers does not do as well. In this way many gardeners are persuaded that there is nothing equal to stable manure, which they continue to use in large quantities, paying in many cases fully twice as much for it as the plant food it contains is worth. There is no doubt but that stable manure is valuable as a fertilizer, and in many cases is indispensable, but at the same time the *quantities* necessary to produce good results could be greatly reduced by using chemical fertilizers to supply plant food and only enough manure to give lightness and add humus to the soil.

Fertilizers for Vegetables and Small Fruits.

What Fertilizers to Use for Garden Crops.

For crops like cabbage and beets, that it is desirable to force to rapid maturity, the kind of the plant food, especially of Nitrogen, is of the greatest importance. Many fertilizers sold for this purpose have all the Nitrogen they contain in insoluble and unavailable form, so that it requires a considerable time for the plants to get it. Another fault is that they do not contain nearly *enough* Nitrogen. Stable manure contains on the average in one ton, 10 pounds Nitrogen, 10 pounds potash, and only 5 pounds phosphoric acid, while the average "complete" fertilizer contains more than *twice* as much phosphoric acid as Nitrogen, a most unnatural and unprofitable ration. A fertilizer for quick-growing vegetables should contain as much Nitrogen as phosphoric acid, and *at least* half this Nitrogen should be in the form of Nitrate, *which is the only ammoniate immediately available as plant food.*

Beets, Onions and Carrots.

The best fertilizer is a mixture of 200 pounds of Nitrate of Soda and 350 pounds phosphate. A small quantity of sulphate of potash should be added when the land is sandy.

How to Apply Phosphatic Fertilizers.

In applying fertilizers it should be remembered that any form of phosphoric acid, such as acid phosphate, dissolved bone-black, bone meal or Thomas Phosphate Powder is only partially soluble, and will not circulate in

the soil. These fertilizers should therefore be evenly distributed over the soil and well mixed with it. This is usually best done by applying broadcast before sowing the seed and before the ground is thoroughly prepared. In this way it gets well mixed with the soil.

Nitrate of Soda, on the other hand, will diffuse itself rapidly and thoroughly throughout the soil wherever there is enough moisture to dissolve it. It can therefore either be applied with the phosphate before sowing the seed or scattered on the surface of the ground as soon as the plants are up. This latter method, Top-Dressing, is usually the best.

For Melons, Cucumbers and Squashes.

The best way is to scatter the fertilizer for two feet around the hills and rake it into the soil with a steel garden rake. This not only mixes the fertilizer with the soil, but it loosens the ground and kills all small weeds that are coming up.

Comparative Availability of Nitrogen in Various Forms.

Some interesting and valuable experiments were made at the Connecticut Experiment Station, to ascertain how much of the Nitrogen contained in such materials as dried blood, tankage, dry fish, and cotton-seed meal, is available to plants.

The experiments were made with corn, and it was found that when the same quantity of Nitrogen was applied in the various forms the crop increased over that where no Nitrogen was applied, as shown in the following table:

Increase of Crop from Same Quantity of Nitrogen from Different Sources.

Sources of Nitrogen.	Relative Crop Increase.
Nitrate of Soda	100
Dried Blood	73
Cotton-seed Meal	72
Dry Fish	70
Tankage	62
Linseed Meal	78

The above table shows some interesting facts. It is evident that only about three-fourths as much of the Nitrogen in dried blood or cotton-seed meal as in Nitrate of Soda is available the *first* season. The Nitrogen in tankage is even less available, only a little over half being used by the crop.

These experiments were made with corn, which grows for a long period when the ground is warm and the conditions most favorable to render the Nitrogen in organic substances available and yet only part of it could be used by the crop.

When it is considered that Nitrogen in the form of Nitrate of Soda can be bought for less per pound than in almost any other form, the advantage and economy of purchasing and using this form is very apparent.

What Fertilizers to Buy.

It is always more economical to buy the different fertilizing materials and mix them at home than to purchase "complete" fertilizers as they are often called. Some do not wish to take pains to get good materials and mix them, and prefer to purchase the "complete" fertilizers. If this be done, *special attention should be given to ascertaining in what form the Nitrogen or "ammonia" exists.* Many of the manufacturers do not tell this, but the Experiment Stations analyze all the fertilizers sold in their respective States and publish the results in bulletins, which are sent free to any one asking for them. These analyses should show in what form the Nitrogen is. *The "complete fertilizers" that contain the most Nitrogen or "ammonia" in the form of Nitrate are the ones to use, and the ones which do not contain Nitrate or which do not give information of this vital point should not be purchased.* If you have on hand a "complete fertilizer" containing a small percentage of Nitrogen or ammonia, and only in organic form, such as cotton-seed, "tankage," etc., it will be of great advantage to use 100 pounds per acre of Nitrate of Soda in addition to this fertilizer. This is often an economical and convenient method of buying fertilizers.

Fertilizing Cotton.

The Alabama Agricultural Experiment Station at Auburn, Alabama, has made some interesting experiments in fertilizing Cotton. Experiments were conducted in many different parts of the State and on various kinds of soil.

It was noticed that in nearly every case 96 pounds Nitrate of Soda, when used with acid phosphate, gave a better yield than 240 pounds cotton-seed meal when used with the same quantity of acid phosphate. The 240 pounds of cotton-seed meal contained more Nitrogen than 96 pounds of Nitrate, *and cost more than the Nitrate*, yet did not give, as a rule, as good results. As a rule, potash did not pay,

except on sandy land. While the "no fertilizer" acre gave only a small yield, the best results were obtained from the combination of Nitrate, phosphate and potash, but where the land was fairly good, the potash did not seem to be necessary.

Cotton-seed meal has been an economical source of Nitrogen, but it tends to make the soil sour, stale and mouldy. Its use should never exclude the use of Nitrate Nitrogen, *i. e.*, Nitrate of Soda, at the rate of 100 pounds to the acre.

Make *two bales* of cotton on the same land with the same labor which now makes one. Nitrate of Soda fed to growing crops at the right time repays its cost many times over.

Experiments with Fertilizers on Cotton.

Locality and Character of Soil.	No Fertilizer.	240 lbs. Acid Phosphate, per Acre.	NITRATE. 96 lbs. Nitrate of Soda 240 lbs. Acid Phosphate, per Acre.	240 lbs. Cotton S. Meal, 240 lbs. Acid Phosphate, per Acre.	NITRATE 96 lbs. Nitrate of Soda 240 lbs. Acid Phosphate, 64 lbs. Muriate Potash, per Acre.
	Yield per Acre. Lbs.	Yield, per Acre, Lbs.	Yield, per Acre, Lbs.	Yield per Acre. Lbs.	Yield per Acre Lbs.
Barbour Co., Sandy Loam	624	672	1216	768	1020
Elmore Co., Gray Sand	469	736	1088	960	1088
Elowah Co., Red Loam	240	616	1000	720	952
Greene Co., Sandy.............	104	512	960	1056	1256
Clay Co., Soil Red..............	389	480	800	704	848
Calhoun Co., Mulatto Soil	171	480	640	624	816
Lawrence Co., Clay Loam	235	600	864	688	904
Cullman Co., Sand and Gravel ..	347	928	1080	1096	1120
Madison Co., Clay Loam	312	448	800	544	800
Randolph Co., Sandy Loam	288	384	752	544	544
Butler Co., Light Sand	200	640	744	760	800
Marengo Co., Dark Sand........	648	816	936	784	968

At least a half of the Nitrogen applied should be in the form of Nitrate of Soda. The reason for this is that all the Nitrogen in the cotton-seed meal is not immediately available. It only becomes so after undergoing the process of soil Nitration. If there is no Nitrate present, the plant must wait until the Nitrogen in the cotton-seed meal becomes nitrated, which, in cool, damp soil takes a considerable time. Thus the plant, in its most critical stage, is held back and checked in its growth, *from which it never fully recovers.*

On the other hand, if a small quantity of Nitrate is used, the plant can take it up at once and get a good strong start by the time the cotton-seed meal is converted into the Nitrate form, the only form that can be used by the plant.

Experiments with Nitrate on Cotton.
South Carolina, 1904.

POUNDS OF THE FOLLOWING MATERIAL TO THE ACRE.

Plot.	Peru Guano	Acid Phos.	Kainit.	C. S. Meal.	Nit. Soda.	Nitrate Potash.	Mur. Pot.	Manufactured Fertilizer. 4-8-4.	2½-8-2	Pounds Seed-Cotton to the Acre.
0000	100	200	200	300	200					1740 lbs.
000	100	200	200	300	100					1110 "
00	200	400	400	600						1140 "
0	100	200	200	300		100				960 "
1										450 "
2		200								450 "
3			200							450 "
4				200						540 "
5					100					600 "
6						100				750 "
7										300 "
8							100			390 "
9	200									540 "
10								200		540 "
11									200	540 "
12		200	200	300						720 "
13		200		300			100			810 "
14										330 "
15		200	200		100					960 "
16		200	200	300	100					1110 "
17		200	200	300	50					870 "
18		200		300	100		66			1050 "
19		300		300	100		100			1140 "
20		300				200				1020 "
21										450 "
22		350		200		200				1290 "
23		350		300		150				1350 "
24	100	200	200	300						780 "
25	200	200	200	300						960 "
26								400		930 "
27		300		300		100				1170 "
28										540 "
29	500									840 "
30	100	200	200	300						900 "
31	100	200	200	300						810 "
32	100	200	200	300						930 "
33	100	200	200	300						780 "
34	600									960 "
35		350		200		250				1230 "
36										480 "
Balance of Farm	100	200	200	300	80					1250 "

The above is a copy of a series of experiments conducted by E. B. Smith, Esq., of Centenery, S. C. Mr. Smith explains the low average production of the 36 experimental plots, 777 lbs., as compared with 1250 lbs. average for the balance of the farm, first by the fact that in many instances no fertilizer or much less than the regular formula for the balance of the farm was used, and also says: "The low average production of the experimental plots as compared with the rest of the farm may also be accounted for by the differences in time of preparation and planting, and the coming up of the crop, which was slow on account of the drought, after planting." In experiment No. 30 Peterkin seed was used, in No. 31 Black seed, in No. 32 Cook's Improved, and in No. 33 Mr. Smith used his own cotton-seed.

The Cotton Bolls on the Nitrate Plot were better developed and larger, and opened better. They did not shed as much during the rainy season. There were also many more bolls on the Nitrate Plot.

Cotton and Fiber Plants.

Cotton is profitably grown on nearly all kinds of soil, but does best perhaps on a strong, sandy loam. On light

uplands the yield is light, but with a fair proportion of lint; on heavy bottom lands the growth may be heavy, but the proportion of lint to the whole plant very much reduced.

The *preparation of the soil must be even and thorough*; light soils should be plowed to a depth of six inches, heavy soils about eight inches. The rows should be four feet apart; on very rich soils the hills may be made twelve inches apart, but on the light soils common to cotton sections twenty-four inches is a better space between plants. About one bushel of seed per acre is the usual allowance.

The plant-food needs of cotton are shown by the plant food actually contained in the whole crop, as follows:

	Pounds.	Ammonia (Nitrogen). Pounds.	Phos. Acid. Pounds.	Potash. Pounds.
Lint	300	.87	.18	2.22
Seed	654	24.30	6.66	7.63
Bolls	404	5.45	1.14	12.20
Leaves	575	16.76	2.57	6.57
Stems	658	6.26	1.22	7.74
Roots	250	1.96	.38	2.75
	2,841	55.60	12.15	39.11

Many fertilizer formulas have been recommended, and by all kinds of authority, and green manuring is widely advised as a means of getting a supply of cheap ammonia; but, with this crop especially, cheap ammoniates are very dear. The cotton plant should have stored up all the food it needs by the 1st or 15th of August; *from this time on growth should be checked that the plant may develop the formation of seed and lint.* If, on the contrary, plant food is still supplied late in the season, new growth is the result, and in *consequence a lessened production of lint and seed. The lower grade ammoniates, such as cotton-seed meal, green manuring, tankage, and dried blood, continue to supply available Nitrogen until checked by cold weather, hence these forms of ammoniates are not desirable for the most economical production of cotton. In order to supply the necessary plant food for the earlier stages of growth, so much of these low grade ammoniates must be used that injury from lack of ripening is almost sure to occur.*

The most rational way of fertilizing cotton is to apply the phosphoric acid and potash with the seed, or just before

seeding. As soon as the plants are well above ground, top dress along the rows with 100 pounds of Nitrate of Soda per acre, and work well in with the cultivator. This furnishes the cotton plant with precisely the Best Form of Ammoniate, viz., Nitrated Ammonia, for rapid growth, and does not continue to push the plant long after new growth should have ceased.

A good formula for a Cotton fertilizer, per acre, is:

Cotton-seed meal	100 lbs.
Phosphate (14 per cent.)	500 "
Muriate of Potash	100 "

One hundred pounds more of Nitrate of Soda should be used as a top-dressing four weeks after planting.

Successful results have been obtained by using Nitrate alone, either at the time of planting, at the ratio of 100 pounds to the acre, or a spoonful of this salt placed around and near each cotton bush later, mixing it thoroughly with the dry soil. Avoid placing the Nitrate on the plant or in contact with it.

For Hemp, 100 pounds per acre may be applied as a top-dressing at the time of planting.

For Flax, 100 pounds Nitrate per acre may be applied as a top-dressing at the time of planting. Apply, also, about 250 pounds of muriate of potash at the time of planting in both cases, with 250 pounds superphosphate. The above ingredients may be mixed and put on in one application.

Fruits.

The following table shows the amount of Nitrogen, phosphoric acid and potash removed from an acre of ground by an average crop of the fruits named:

	Nitrogen. lbs.	Phosphoric Acid. lbs.	Potash lbs.
Grapes, crop of 10,000 lbs	17	15	50
Prunes, crop of 30,000 lbs	45	16	80
Apricots, crop of 30,000 lbs	69	21	84

It will be noticed that while a crop of prunes takes practically no more phosphoric acid from the soil than a crop of grapes, yet the amount of Nitrogen removed is nearly three times as much, and in the case of apricots over

four times as much as required by grapes. It is evident that a few crops of plums or apricots will materially reduce the amount of Nitrogen in the soil, which is usually deficient to start with and therefore this element of plant food must be replenished or the fruit will soon deteriorate in size.

"Time to apply should be when fruit is half grown, and cultivate in to get the Nitrate mixed with the moist soil."

Quantities Required and Time to Apply.

Unless it is known that there is sufficient phosphoric acid and potash in the soils, superphosphate or bone meal, and if necessary to furnish sulphate of potash, wood ashes, apply early in the winter or early spring. Two or three pounds of bone dust and one pound sulphate of potash or ten pounds unleached wood ashes per tree would be about the right quantities. The Nitrate of Soda should be applied after the fruit is set at the rate of two to three pounds per tree. It is important that the fertilizers should be well mixed with the soil, and that they be applied not close to the trunks of the trees, but considerably further out than the branches reach.

Figs.

After investigating the requirements of the fig, Professor George E. Colby, of the University of California Experiment Station, says:

"The Fig leads among our fruits in its demand upon the soil for Nitrogen. Thus we find for the southern localities especially, the same necessity of early replacement of *Nitrogen* in figs and stone fruit as for Orange orchards, and partly for the same reason, viz., that *California soils are usually not rich in their natural supply of this substance.*"

Nitrate of Soda will furnish the necessary Nitrogen in its most available form, and at less cost than any other material. It will probably be best to use in addition to the Nitrate an equal quantity of bone meal phosphate, say two pounds of each per tree, applied as recommended for plums and apricots.

Profitable Onion Cultivation.

Adaptability of the Onion to all Soils.

There is no crop that can be grown so successfully on a large scale, on such a variety of soil and climate, and that will respond more profitably to intelligent cultivation and fer-

tilizing, than the onion. The American farmer has usually been willing to leave the growing of this savory vegetable almost entirely to the enterprising foreign immigrant, who often makes more net profit at the end of the season from his five acres of onions than the general farmer makes on one hundred acres. The weeder and the improved wheel-hoe have made it comparatively easy to care for the crop; there is no reason why the progressive farmer who is looking about for a New Money Crop should not raise onions with ease and profit.

We shall consider here the growing of onions only as a field crop for the fall and winter market. The onion can be successfully grown anywhere in the United States where other vegetables thrive.

The reason that onions have not been more generally grown by farmers is owing to the mistaken idea that it is impossible to grow them without the application of vast quantities of stable manure, but Onion-growing with the aid of chemical fertilizers is not only much cheaper, but the average crop is much larger. The excessive quantity of stable manure required to grow a maximum crop tends to make the land too open, when the great secret of onion culture is to get the land solidified. The ploughing under of so much bulky manure also tends to cut off the moisture supply from below, which is so important in the quick growth of crops of this nature and which can only be obtained by having the soil very compact and in fine tilth so as to promote the capillary movement of the soil moisture to the surface, where it may be retained for the use of the crop by means of frequent and shallow cultivation.

The advantage of using Nitrate of Soda instead of stable manure as the source of Nitrogen for this crop is plainly evident, as the Nitrate supplies the most beneficial ingredient contained in the stable manure (Nitrogen), and in a form in which it is not dependent upon soil bacteria and weather conditions to make it available for the young plants *when they need it most.* If it be necessary to add humus to the soil in the form of stable manure it should, if possible, be applied a year in advance.

Considering the fact that Nitrogen is the element most frequently lacking in our soils, and knowing that the onion responds most liberally to a plentiful feeding of ammoniate

ONION EXPERIMENT.—S. M. Harris.

Both plots fertilized—per acre, 400 lbs. Acid Phosphate, 120 lbs. Muriate Potash.

No Nitrate.
Yield, 4,500 lbs. per acre.

300 lbs. Nitrate of Soda per acre, applied June 4th after weeding,
Yield, 9,900 lbs. per acre.
Increased yield from use Nitrate, 5,400 lbs.

Season very unfavorable.

fertilizers, it should have a liberal supply of that element in the best possible form, *viz.:* Nitrate of Soda. We know that if a young pig or calf does not have an abundance of the right kind of food when it is young it becomes stunted in growth and never recovers from it, no matter how judiciously it is afterwards fed. The intelligent cultivator has learned that the same rule holds good in the feeding of plants; hence the great importance of an immediately available supply very early in the season just as the plant is starting growth, and at which time it can only be obtained from an application of Nitrate of Soda, since the Nitrogen in other ammoniates does not become available until after the soil itself has warmed up to summer temperature.

Character of Plant Food Required by the Onion.

The presence of Nitrate at the outset enables the plant to start off with a good healthy root growth, whereby it is better able to take up later the other and more complex food elements.

If it cost $45.00 per acre for rent, ploughing, harrowing, seeding, weeding and cultivating to produce a crop of onions *ready to harvest,* then

The crop of 225 bushels per acre costs 20 cts. per bushel.
The crop of 450 bushels per acre costs 10 cts. per bushel.
The crop of 900 bushels per acre costs 5 cts. per bushel.

The latter yield is not at all unusual when the crop is properly fed with Nitrate of Soda and supplementary chemical fertilizers.

In the first place, the onion, contrary to the general belief, does not require any *special* kind of soil, such as muck, black sand, etc., but will do well on any good corn or potato soil, provided it is not too sour or so stony as to interfere with the early and frequent cultivation of the crop.

Even though a field is somewhat stony, it will pay to rake the stones into the dead furrows which should be about twenty feet apart, as the stones would make it impossible to do good work with the weeder and wheel hoe.

Necessity of Moisture in Soil.

In selecting your field for onions it is, of course, advisable to choose one that is likely to be affected as little as possible in the event of a severe drought, and it is for this reason that onions, cabbage and those crops that espe-

cially require large quantities of moisture during their growth are usually grown upon bottom lands.

Cultivation.

Ploughing for the onion crop should preferably be done in the fall to a depth of eight inches or more, leaving the soil in the furrow to be acted upon by the frost during the winter. It at the same time becomes more compact—*the onion likes a solid seed bed.* When for any reason the ploughing has to be done in the spring it should be done very early and worked down solid. The lands should be narrow, so that the numerous dead furrows will drain off excessive surface moisture early in the spring, as it is desirable to get the seed sown very early.

Free Use of the Harrow and Pulverizer.

As soon as the condition of the soil will permit in the spring it should be worked over with the harrow or pulverizer as deeply as the ground will allow and rolled with a heavy roller, which should be followed at once with a light harrow, which will loosen the surface soil and form a light mulch to help conserve the moisture. This operation should be repeated each week until it is time to sow the seed, which is in this latitude when the apple trees begin to bloom.

The seed should be sown with a hand seed drill about three-quarters of an inch deep and in rows about fifteen inches apart, using about six pounds of seed per acre.

In about five days after the seed is sown the field should be gone over with the weeder to destroy any weeds that have started to germinate near the surface, and again in three or four days or before the onions come up. Always run the weeder *across* the rows.

After the onions are up so that you can see the rows cultivate them carefully with the wheel hoe using the sharp blades that are made for that purpose and going not more than one-half inch deep.

As soon as any more weeds appear to be germinating go over the rows again with the weeder. The weeder may appear to be doing some damage, but if handled carefully there is no danger, as we have sown an extra pound of seed to allow for some being pulled out.

When the onions are about four inches high it will probably be necessary to weed them once by hand. This will not prove to be a tedious job if the weeder and wheel hoe have been used with good judgment.

Fertilizing.

Nitrate should be applied as follows: One hundred pounds scattered broadcast over the field within a week after the seed is sown and before the plants break through the ground, and two more applications broadcast consisting of 100 pounds each at intervals of two or three weeks, depending somewhat upon the appearance of the plants as to growth and color.

When to Apply Nitrate.

Generally speaking the Nitrate should all be applied during May and June, though if a drought occurs in July, and the onions show signs of turning yellow at the tips, an extra dressing of 50 pounds per acre may be applied to advantage. In a wet season avoid putting it on late, as it might aggravate the tendency to produce a considerable number of scullions. It should only be applied when the plants are dry.

Use of Common Salt.

The onion is an alkali-loving plant, and, like asparagus, seems to have a peculiar fondness for salt. The results of experiments on widely different soils show that it nearly always responds profitably to an application of about 200 pounds of salt per acre. This guides us to the choice of kainit for this crop, as that product contains about 35 per cent. of chloride of soda or common salt, which also aids in conserving the moisture in the soil. Good judgment must be used, however, as the kainit might have a harmful effect in a wet season on a low and naturally damp soil.

About 400 pounds of kainit per acre should be used, as a rule. It should be drilled into the entire surface of the ground early in the spring to a depth of at least three inches, for the kainit becomes *fixed* in the soil very quickly and should be rather deep, so as not to attract the feeding roots too near the surface. In case wood ashes or muriate of potash are used the time of making the application should be the same. Most vegetables will give greatly increased returns from the use of chemicals if lime is employed in conjunction with them.

An application of 75 bushels per acre of ground quicklime has also proved preventive of onion smut.

Use of Thomas Slag and of Lime.

In regard to the best source from which to obtain the phosphoric acid for our onions it is plain that we must be guided by the character of the soil. For instance, if it is

a strong, deep soil, rich in humus, with an excessive quantity of organic matter and acid, it is deficient in lime. On muck and acid soils basic slag if very finely ground seems to give better results with most crops than acid phosphate. This is due to the fact that the basic slag contains from 40 to 50 per cent. of lime, which is necessary to neutralize the excess of acids present which are detrimental to plant growth.

If the soil is a medium heavy clay upland and not acid it is best to use the acid phosphate which contains, besides the phosphoric acid, about 50 per cent. of calcium sulphate (gypsum). *This unlocks the natural potash in the soil.*

The quantity of either to apply on ordinary soils is 1,000 pounds per acre very early in the spring, so that in fitting the ground it will become very thoroughly incorporated with the soil before the onion seed is sown.

The following table gives the actual field results of six years' experiments with fertilizers and seven years with manures at the rate of 30 tons per acre:

	Manure.	Chemicals.
Tons per acre, average	8.90	14.02
Market *value per ton*, average	$18.16	$20.52

The crop grown with chemical fertilizers was 5.12 tons greater per acre, or a gain over the stable manure of nearly 58 per cent.; while the Nitrate crop averaged $2.36 greater market value per ton, an advance over the manure-grown crop of 13 per cent.

Stable Manure and Artificial Fertilizer Upon Fruit Trees.

In this country the manuring or fertilizing of fruit plantations is very commonly neglected, but in Europe fruit trees are as regularly treated with plant food as staple crops. According to the investigations of Professor Barth-Colmar and Dr. Steglich, Dresden, the wood, foliage and fruit of apple, pear, cherry and bush fruits consume yearly per square yard of surface shaded by the tree or bush, 219 grains of Nitrogen, 65 grains of phosphoric acid, and 284

grains of actual potash; equivalent to fertilizer chemicals as follows:

Nitrate of Soda, per square yard	3.5	ounces
Acid Phosphate, per square yard	1.5	"
Muriate Potash, per square yard	1.5	"

Amount of Ration of Plant Food for One Tree.

Except on high-priced land, garden crops should not be grown in orchards, but where this custom is followed the quantity of plant food should be increased to suit the needs of the additional crop to be grown. For fruit alone apply between the fall of the leaf and the bursting of the buds, per square yard of surface shaded by the tree, the quantities of plant food shown above to be the actual needs of the crop. If the trees have made a weak growth the previous season, or have heavily fruited, apply between May and July about one ounce of Nitrate of Soda per square yard of surface; this in addition to the previously applied plant food.

The practical effect of artificial manures for fruit cannot be denied, not only for quantity, but also for the quality of the crop. Stable manures seem to fail of regular bountiful results, probably because the stable manure supplies its ammonia in the Nitrated form very irregularly, and fruit trees can use ammonia plant food only in the Nitrated form. Practical figures showing the profitableness of artificial manures, fertilizers, have been shown by many experiments, particularly by those conducted at Feldbrunnen, near Osterode, Germany.

The rational fertilization of fruit trees depends somewhat upon their period of growth; young trees need ample supplies of Nitrated ammonia and potash to develop and ripen new wood. Later, at the bearing age, phosphoric acid and Nitrated ammonia are required for the formation of fruiting buds. These two phases in the making of an orchard should have due consideration and plant food used accordingly.

	Apples.	Cherries.	Plums.
Unfertilized	100 lbs.	100 lbs.	100 lbs.
Fertilized	3,420 lbs.	218 lbs.	329 lbs.

Asparagus.

The soil should be sandy, or a light loam. As the crop remains in position for many years, the land should be

selected with that fact in mind. The soil must be kept very clean and mellow. Stable manure is very objectionable on account of its weed seeds. It is only by a quick, even growth that large, crisp stalks can be produced, and there must be no check through a scanty supply of plant food. In the spring, as soon as the ground can be worked, clear off the rows and loosen up the soil, and apply broadcast along the rows a top-dressing of Nitrate of Soda, from 200 to 300 pounds. With this crop, the full application of Nitrate can be made at one time.

Market Gardening with Nitrate.

Results in an Unfavorable Growing Season with Low Prices for Products.

The following is the result of a practical study of conditions on a large truck farm, near New York. In every case the operations of the farm were carried out on a strictly business basis. The soil is a heavy clay with a rather intractable clay subsoil, decidedly not a soil naturally suited to growing garden crops. The weather was unfavorable, including the most severe drought in thirty years; from March 22d to July 8th practically no rain fell. Owing to the unfavorable season, the grade of garden products was low causing a low ruling in prices. Details by crops follow:

Asparagus.

The bed was twenty years old, and had been neglected. As soon as workable, it was disc-harrowed, and later smooth-harrowed with an Acme harrow. Nitrate of Soda was applied to the three test plots April 10th, 200 pounds per acre, sown directly over the rows and well worked into the soil. A second application of 100 pounds per acre was made to plot 1 April 24th; and, on the 29th, a third application of equal amount.

The experiment comprised three plots, two fertilized with Nitrate of Soda, and one without Nitrate, plot 3. Plots 1 and 2, treated with the Nitrate, produced marketable stalks ten days in advance of plot 3, a very material advan-

tage in obtaining the high prices of an early market. The results were as follows, in bunches per acre:

Plot and Fertilizer.	Bunches per acre.	Gain.
3. No Nitrate	560	——
2. 200 lbs. Nitrate	680	120
1. 400 lbs. Nitrate	840	280

The financial results are as follows, prices being those actually obtained in the New York Markets:

	Plot 1.	Plot 2.	Plot 3.
Fertilizer, Nitrate	400 lbs.	200 lbs.	——
Gross receipts	$207.90	$161.50	——
Fertilizer cost.	8.40	4.20	——
Applying fertilizer.	2.00	1.00	——
Net receipts.	197.50	161.50	$112.00
Nitrate made gain.	85.50	44.30	——

The use of 400 pounds of Nitrate of Soda produced on plot 1 a gain of $85.50 on a fertilizer and application cost of $10.40; the use of 200 pounds of Nitrate returned a similar gain of $44.30 on a fertilizer and application cost of $5.20.

Snap Beans.

The Beans were grown for pods, or what is known as string beans. Three varieties were experimented with, Challenger, Black Wax, and the Red Valentine. Seeds were drilled in May 10th, in rows two feet apart; on May 22d, 100 pounds of Nitrate of Soda were applied per acre, and on the 27th, another application of 150 pounds was drilled in. June 12th, an application of 50 pounds was drilled along the rows, followed by 100 pounds June 19th; in all 400 pounds of Nitrate of Soda per acre. Half the field was not treated with Nitrate. In the case of the Black Wax beans, the Nitrated land gave a crop 6 days in advance of the part not treated with Nitrate, and the same gain was made by the Nitrated Valentine beans. The Black Wax beans treated with Nitrate produced 75 per cent. more marketable crop than the non-Nitrated portion, and the Valentine variety 60 per cent. Taking into consideration the enhanced price due to earlier ripening, the average price of the Nitrated black wax beans averaged some 60 per cent.

Increase in Crop and Better Quality Resulted as well as Saving in Time.

higher than the portion of the field not treated with Nitrate of Soda; in like manner, the increased price of the Valentine beans was 45 per cent.

Beets.

Table Beets Grown on Nitrate were Ready for Market 16 Days Ahead of Unfertilized Plots.

The crop must be forced to quick growth in order to obtain tender, crisp vegetables, quickly salable and at good prices. Nitrate of Soda was compared with unfertilized soil, with the result that on the Nitrated plots, marketable beets were pulled 56 days from seeding; the unfertilized plot required 72 days to produce marketable vegetables. Nitrate of Soda was applied at the rate of 500 pounds per acre, in four applications.

500 lbs. Nitrate of Soda to the acre, in four applications. No Nitrate.

Early Cabbage.

How a Crop was Saved from Total Failure.

The cabbage plots were thoroughly worked up, and planted to Henderson's Early Spring Variety. Part of the soil was treated with Nitrate of Soda at the rate of 575 pounds per acre, in five applications ranging from May 1st to June 17th. The part of the plot not treated with Nitrate of Soda was a total failure, but allowing the same

number of plants as the fertilized portion, and also allowing for difference in price on account of later ripening, the crop on the portion not treated with Nitrate should have returned a gross amount of $292.50. The Nitrated portion returned gross receipts of $720, from which deducting $19.50 for fertilizer and application of same, we have $700.50 for Nitrate of Soda as compared with $292.50 without Nitrate, a net profit for the Nitrate of $408. That is, for every dollar spent for Nitrate of Soda, the crop returned an additional $21 nearly.

A Dollar Spent in Nitrate Returned $21.00 in Increased Crop.

Cabbage.

Cabbage requires a deep, mellow soil, and rich in plant food. Early maturing cabbage, perhaps the most profitable method of growing this vegetable, produces 30,000 pounds of vegetable substance to the acre, using about 140 pounds of ammonia, 129 pounds of potash, and 33 pounds of phosphoric acid, all as actually assimilated plant food. The crop must be fertilized heavily. As the soil is thoroughly fined in the spring, there should be incorporated with it by rows corresponding to the rows of plants, about 1,500 pounds of fertilizer per acre. After the plants have set and have rooted, say a week from setting, apply along the rows a top dressing of 200 pounds of Nitrate of Soda per acre and work into the soil with a fine toothed horse hoe; the soil must be kept loose to a depth of at least two inches, and consequently there will be no extra labor in working this fertilizer into the soil. Some three weeks later incorporate in the same manner into the soil 300 to 400 pounds of Nitrate of Soda. *Soil Nitration* cannot be depended on under any circumstances for supplying enough natural Nitrate for cabbage. Nitrate of Soda is the only immediately predigested Nitrated ammoniate in the market and is an absolute necessity for early cabbage, and should be used liberally. This crop should not follow itself more than twice, as by so doing there is no little danger of serious disease to the crop.

Formula for Cabbage per acre:

Nitrate of Soda	200 lbs.
Superphosphate	350 "
Sulphate of Potash	100 "

Celery.

Crisp stalks of rich nutty flavor are a matter of rapid, unchecked growth, and plant food must be present in unstinted quantity, as well as in the most quickly available form, the best example of which is Nitrate of Soda. The soil was plowed early in May, and subsoiled, thoroughly breaking the soil to a depth of 10 inches. Thirty bushels of slaked lime were broadcasted per acre immediately after plowing, followed by a dressing of 20 tons of stable manure, all well worked into the soil. Plants were set May 10th. The tract was portioned into three tracts for experimental purposes; plot 1 received 675 pounds of Nitrate of Soda per acre in six applications, May 16th, 22nd, June 1st, 10th, 17th and 24th. Plot 2 received 475 pounds in five applications, May 16th, 22nd, June 1st, 17th and 24th. Plot 3 was not treated with Nitrate of Soda.

Extraordinary Returns on Celery.

Plot 1 was ready for market July 6th, and was all off by the 10th. Plot 2 was ready for market July 11th and was all harvested by the 14th. Plot 3 was practically a failure and was not harvested. Plot 1, being first in the market, had the advantage of the best prices; the gross receipts were, per acre, $957.80; from which must be deducted $18.67 for Nitrate of Soda and the application of same—a net result of $939.13 per acre. Plot 2 gave a gross return of $676.30, from which $13.72 must be deducted for fertilizer, leaving $662.58 per acre net. Plot 1 makes therefore a gain of $276.55 over plot 2, simply from the earliness in maturing, due to the heavy applications of Nitrate, for the total crop was approximately the same for both plots.

Cucumbers.

Plants were set in box frames May 4th. The frames were well filled with rotted manure, and were banked as a protection against late frosts. A portion of the field was treated with Nitrate of Soda; on May 10th each plant was given a quart of a solution made by dissolving three pounds of Nitrate of Soda in 50 gallons of water. Applications in quantity the same were made on the experimental plot May 16th, 22nd, 29th, June 3rd, 9th, 15th, 22nd and 26th; making a total of 165 pounds of Nitrate of Soda per acre.

On June 27th the experimental plot was setting fruit rapidly, while the plot not Nitrated was just coming to bloom. The Nitrated plot was given on June 29th a quart of a solution made by dissolving two ounces of Nitrate of Soda in a gallon of water; and this application was repeated July 3rd, 7th, 15th, 24th, and August 8th. This practically doubled the Nitrate application.

Gain in Time in this Crop Very Remarkable, Two Weeks in Advance.

The first picking on the Nitrated plot was made July 1st, on the non-Nitrated plot July 22nd, when prices were at the lowest point. After the early market season was over, the vines were treated for pickling cucumbers, the Nitrated plot receiving 50 pounds of Nitrate of Soda dissolved in water as before; later, two applications of a quart each, containing half an ounce per gallon. The result was that the vines continued bearing until cut down by frost. The estimated yields were as follows: Nitrated plot, per acre, 6,739 dozen, plot not Nitrated gave per acre 948 dozen.

Sweet Corn.

The crop was planted on rather poor soil. Seed was planted May 4th, and the cultivators started May 12th. A portion of the field was selected for experiment, and on this 75 pounds of Nitrate of Soda were applied per acre May 20th, drilled close to the row. A second application of the same amount was made May 26th, and on June 5th a third application. On June 17th 100 pounds per acre were applied and cultivated into the soil. The total Nitrate applied to the experimental plot amounted to 325 pounds per acre. The Nitrated plot ripened corn 5 days ahead of the non-Nitrated portion, and *produced 994 dozen* ears against 623 *dozen from an acre not treated* with Nitrate of Soda. The Nitrated crop, being earlier in the market, brought better prices; the gross return being $99.40 per acre as compared with $62.30 for the non-Nitrated plot. The cost of the Nitrate and its application expenses amounted to $9.75 per acre, leaving a net gain from the use of Nitrate of Soda, of $27.35 per acre.

Egg-Plant.

The plants were set in the usual manner, part of the tract being treated with Nitrate of Soda at the rate of 475 pounds per acre to observe the practical value of the Nitrate for forcing. Before setting, the plants were given a light application of Nitrate in solution. June 1st 150 pounds were applied, on the tenth this was repeated, and on June 22nd a third application was made. The Nitrated plot produced marketable fruit July 5th, the non-Nitrated plot did not reach the market until July 26th. *The Nitrated plot produced per acre 33,894 fruits, all of good quality; the non-Nitrated plot produced only 8,712 fruits per acre.*

Early Lettuce.

The plants were started in the hot-house, and pricked into cold frames; April 26th they were set in the field. The Nitrate applications on the experiment plot were per acre as follows: April 29th, 100 pounds; May 4th, 150 pounds;

750 lbs. Nitrate of Soda to the acre, in 5 applications. No Nitrate.

May 12th, 200 pounds; May 18th, 200 pounds; May 23rd, 100 pounds; a total of 750 pounds per acre. The Nitrated plot was first cut May 26th, and at this time the non-Nitrated plot was just beginning to curl a few leaves towards the heart for heading. Approximately, *the Nitrated plot produced*

per acre 1,724 dozen heads, and so early to the market that the average wholesale price was 25 cents per dozen; per acre, $431.00. From this we must deduct $20.00 for Nitrate and the expense of applying same, leaving net $411.00. *On the non-Nitrated plot only about 4 per cent. of the plants headed, and these reached the market three weeks late.* The financial statement shows 48 dozen heads at 10 cents, or a net return per acre of $4.80. That is, without the Nitrate dressing, the crop was a failure.

Onions.

The soil was in bad condition, and was liberally limed. Seeding was completed April 15th, and the plants were rapidly breaking ground by the 28th. The tract was divided into three plots; plot 1 received 675 pounds of Nitrate of Soda in six applications at intervals of a week or 10 days;

675 lbs. of Nitrate of Soda to the acre, in 6 applications. — 375 lbs. of Nitrate of Soda to the acre, in 4 applications. — No Nitrate.

plot 2, 375 pounds in four applications; plot 3 was not treated with Nitrate. The Nitrated plots seemed least affected by the exceptionally dry weather, but the crop on all the plots was no doubt reduced by the unfavorable conditions. The following table gives the results by plots, computed to an acre basis:

	Nitrate, 675 lbs.	Nitrate, 375 lbs.	No Nitrate.
Total yield	756 bu.	482 bu.	127 bu.
Per cent. scullions	1.5	1.7	19.0
Average price per bushel	75 cts.	65 cts.	35 cts.
Total receipts	$567.00	$313.30	$44.50
Fertilizer cost	20.17	9.30	——
Total net receipts	546.83	304.00	44.50

The results show very clearly that but for the Nitrate applications, the crop must have been a failure in every respect.

Early Peas

This crop was planted under same conditions and in like manner to the snap beans; 300 pounds of Nitrate of Soda were applied per acre, to the experiment plots. Two varieties were planted, early and late. The results were:

	Early.		Late.	
	Nitrate.	Nothing.	Nitrate.	Nothing.
Date planted	April 15.	April 15.	May 1.	May 1.
First picking	June 8.	June 17.	June 29.	July 4.
Gain to Market	7 days.	———	5 days.	———
Period of bearing	11 days.	8 days.	10 days.	6 days.
Crop on first picking	55 p. ct.	40 p. ct.	57 p. ct.	38 p. ct.
Total yield (p. ct.)	165	100	168	100

The season was very unfavorable for this crop, yet the results show that the Nitrate made a powerful effort to offset this disadvantage. The earliness to market in this case is as pronounced as in the other garden crops, and is one of the most profitable factors in the use of Nitrate of Soda. The lengthening of the bearing period is an added advantage.

Early Potatoes.

Ploughing was finished the second week in April, and limed at the rate of 35 bushels per acre. Furrows were opened three feet apart, and 750 pounds per acre of a high-grade fertilizer worked into the rows. May 1st the potatoes were breaking ground, and 100 pounds of Nitrate of Soda were applied per acre on the experiment plot. On the 11th 200 pounds of Nitrate were applied, and on the 29th 150 pounds more were cultivated in with a horse-hoe. The total Nitrate application per acre was 450 pounds. The Nitrated plot was harvested July 6th, and retailed at an average price of $1.60 per bushel; the plot not treated with Nitrate was dug July 17th, eleven days later, and the highest price obtained was 80 cents per bushel. The Nitrated plot produced per acre 19 bushels unmarketable tubers, the non-Nitrated plot 46 bushels. The total crop marketable was 297 bushels for Nitrate, and 92 bushels for non-Nitrated plot. Deducting the cost of Nitrate of Soda and the expense

of applying same, the Nitrated crop was worth $463.30 per acre, while the non-Nitrated plot returned only $69.00 per acre. For every dollar expended for Nitrate of Soda, the crop increase gave $30.18 return.

Late Potatoes.

Conditions same as in the case of early potatoes, except the Nitrate of Soda was used at the rate of 500 pounds per acre, in five applications. The crop per acre on the Nitrated plot, marketable tubers, amounted to *374 bushels;* on the non-Nitrated plot the yield amounted to *231 bushels* marketable tubers. The gain for Nitrate of Soda was 143 bushels, or nearly 62 per cent. increase.

Early Tomatoes.

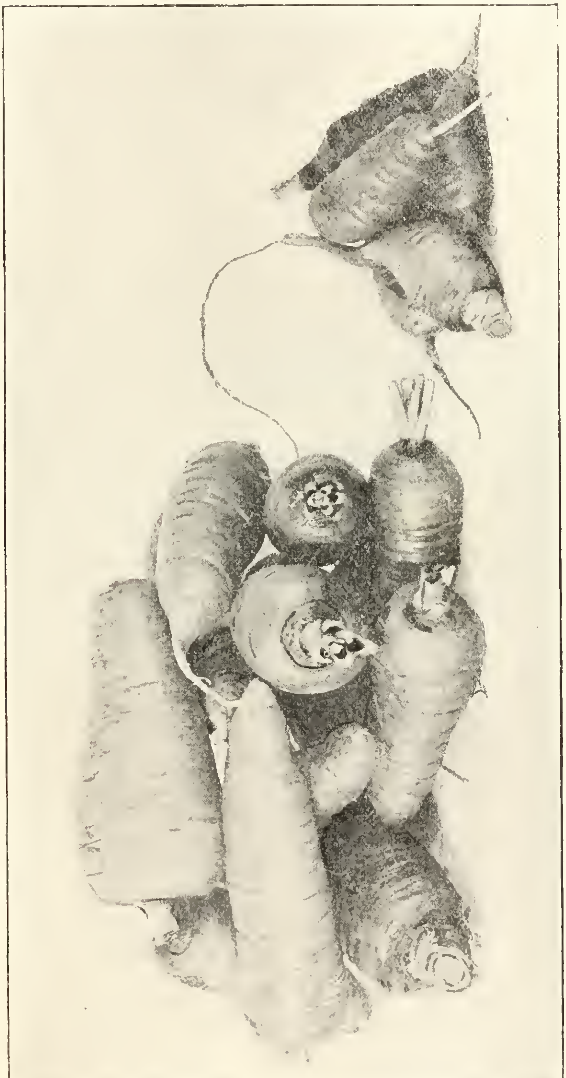
With this crop the object is to mature quickly, rather than obtain a heavy acre yield; one basket of early tomatoes at $1.25 is worth more than 15 baskets later in the season, when the price is about 8 cents per basket. The plants to be used on the Nitrated plot were treated with a diluted solution of Nitrate four separate times. Plants were field set May 17th, and given six applications of Nitrate of Soda: 1st, 100 pounds per acre soon after setting out; 2nd, 3rd and 4th of 75 pounds each; and 5th and 6th of 50 pounds each—in all, about 450 pounds per acre. The results were:

	Nitrate.	No Nitrate.
Plants set out in field	May 17.	May 17.
First picking	June 30.	July 19.
Days, setting to first picking	43	62
Crop at $1.00 and upward per basket	40 p.c.	———
" " .75 " "	30 "	10 p. c.
" " .50 " "	20 "	15 "
" " .30 " "	10 "	20 "
" " .25 " "	———	25 "
" " .15 " "	———	15 "
" " .08 " "	———	15 "
Estimated yield per acre, baskets	500	600
Gross receipts	$377.50	$190.20
Cost of fertilizer and application	10.35	———
Net receipts	367.15	190.20
Gain per acre for Nitrate	176.95	———

The indicated gain amounts to a return of $17.09 for every dollar expended for Nitrate of Soda.

The experiments detailed in this pamphlet are all on a working basis. In every case the object was to force the

Late Carrots.



No Nitrate.

300 lbs. Nitrate of Soda to the acre, in 2 applications.

crop to an early yield, and while the applications of Nitrate of Soda seem large and are large in proportion to the actual

needs of the crops grown, at the same time *the nature of market-gardening requires free use of immediately available plant food,* and the results show that such use is very profitable. Other crops than those enumerated were experimented with, notably Carrots, Kale, Lima Beans, Melons, Rhubarb, Spinach, Strawberries, Endive and Kohl-Rabi. While the detail of results is not given, illustrations from actual photographs show the increased growth from the use of Nitrate of Soda.

Late Spinach.

350 lbs. Nitrate of Soda to the acre, in 2 applications. No Nitrate.

Cantaloupes.

A continuous and rapid growth in Cantaloupes is essential to earliness and a good crop, and Nitrate of Soda under the proper conditions and with proper care, will yield just such results. A dressing of Nitrate of Soda alongside the rows in cultivating, in addition to the general fertilizer used, has been most successful. A general fertilizer may be made up as follows:

Nitrate of Soda	400 lbs.
Dried Blood or Cotton-Seed Meal	400 lbs.
Superphosphate, 14 per cent.	500 lbs.
Sulphate of Potash	200 lbs.

Hints for Right Use of Nitrate.

The points to be observed in the use of Nitrate of Soda are: Avoid an excess; make frequent small applications rather than single large ones; avoid wetting the foliage with solutions of it; do not sprinkle the wet foliage with dry Nitrate; and in general Nitrate must not be allowed to come in contact with the stems or leaves of plants. Nitrate of Soda is a Nitrated ammoniate, and is immediately available as plant food. The fertilizer suggested above may be applied at the rate of 1,500 pounds per acre. Subsequent applications of Nitrate of Soda may be made at the rate of 100 pounds per acre at intervals of two or three weeks during the growing season. Apply the Nitrate well mixed with fine dry soil at the rate of $\frac{1}{4}$ ounce, to $\frac{1}{2}$ ounce per hill. The general fertilizer may be economized somewhat by using a handful in each hill rather than by making a general application.

The *Medical Record* for July had an article on "Typhoid Fever from Sources Other than Water Supply," the point of which was *that infection from the soil was more common than most physicians supposed.* The *germ may be in vegetables*, in dust blown by the wind, and flies are active agents in carrying it about. The writer warns those who have the care of the sick never to bury the excreta of patients. It is the surest way, he says, of "perpetuating the disease in any locality, keeping it alive for years and causing it to become epidemic." He observes that "there is good evidence that the typhoid bacillus grows to the surface in a mixture of soil and fecal matter, like a fungus in a hot-bed, so that burial is no protection whatever against its spread." Unfortunately, in almost every town or village there are physicians who ignorantly insist on burying typhoid material in the earth as the best way to dispose of it. Chemical fertilizer should always be used by market gardeners.

How to Use Chemical Fertilizers to Advantage.

How All Crops Grow.

Crops grow only in consequence of the food placed at their disposal; practically, the food plants consist of certain combinations or mixtures of ammonia, phosphoric acid and potash. Not any one, nor any two, but all three. All soils contain some of these plant foods, and few soils contain them in very large quantities. Fortunately for the permanence of agriculture, nature does not permit these natural supplies to be drawn upon freely, and any attempt to overforce the soil by injudicious farming is met by a temporary exhaustion.

As to the Nature of Chemical Manures.

The so-called "artificial manures" are simply chemical or organic substances which contain one or more of the three elements of plant food.

Nitrate as a Top-Dressing for Grains, Grasses, Root-Crops, Pastures, Soiling Crops.

The use of Nitrate of Soda is well known as a top-dressing for small grains. Wheat on strong clay will repay an application of 100 pounds of Nitrate per acre, even if already heavily manured.

For Roots 100 pounds at seed time and 100 pounds after thinning is found profitable.

How Nitrate Increases Wheat Crops.

The form of ammoniate most active as plant food is the Nitrated form, namely: Nitrate of Soda. All other ammoniates must be converted into this form before they can be used as food by plants. Sir John Lawes wisely remarks: "When we consider that the application of a few pounds of ammonia (Nitrogen) in Nitrate of Soda to a soil which contains several thousand pounds of ammonia in its organic form, is capable of increasing the crop from 14 to 40, or even 50 bushels of wheat per acre, I think it must be

apparent to all that we have very convincing evidence of value of Nitrate." The ammonia of Nitrate of Soda, Nitrated ammonia, it may be called for convenience, is immediately available as plant food, and it should therefore only be applied until plants are ready to use it. By such a ready supply of available ammoniate plant food, young plants are able to establish such a vigor of growth that they can much better resist disease, and the attacks of insects and parasites. The famous experiments of Lawes and Gilbert at Rothamsted have demonstrated that cereals utilize more than three times as much of the Nitrogen in Nitrate of Soda as of the Nitrogen (ammonia) contained in farmyard manure; in practice, four and one-half tons of farmyard manure supply only as much available ammoniate usable plant food as 100 pounds of Nitrate of Soda.

Nitrate Compared with Farmyard Manure.

Wheat.

Wheat Experiments in England.

From 100 to 200 pounds of Nitrate of Soda per acre should be broadcasted on wheat, as soon as the new growth shows in the spring. The results of such treatment are shown by experiments made by three English gentlemen, which are tabulated as follows:

I.	No Nitrate, 23 bu.	300 lbs. Nitrate, 33.5 bu.	Gain 46 p. ct.
II.	" 15 "	300 " " 28.0 "	" 87 "
III.	" 34 "	300 " " 49.0 "	" 44 "
		Average	" 59 "

Cotton-seed Meal Compared with Nitrate.

Another illustration is an experiment made by the late Dr. Voelcker; 672 pounds of cotton-seed meal were used in comparison with 275 pounds of Nitrate of Soda, with the result that the latter gave a return of 46.75 bushels per acre, *a gain over the cotton-seed meal of nearly 24 per cent.*, the above enormous application of cotton-seed meal yielding but 37.7 bushels per acre.

Oats.

An authenticated experiment made by Mr. P. Dickson, of Barnhill, Laurencekirk, N. B., gave a return from the use of 112 pounds of Nitrate of Soda of 64 bushels per acre,

while the soil without Nitrate gave a crop of only 36 bushels. Top-dressings for oats should average 100 pounds to the acre. *It should always be applied some ten days after the young plants have broken ground.*

Barley.

In an experiment at Woburn, made for the Royal Agricultural Society of England, by the late Dr. Voelcker, the following results were obtained:

Mineral manures and sulphate ammonia............36.75 bushels per acre.
Nitrate 275 lbs. and minerals.......................42.50 bushels per acre.

Gain for Nitrate, 16 per cent.

The ammonia salt and the Nitrate used contained the same amount of ammoniate plant food. Compared with cotton-seed meal, 124 pounds of Nitrate of Soda gave 49.5 bushels barley per acre as compared to 37 bushels from 1,000 pounds cotton-seed meal applied the previous year. Gain for Nitrate 33.7 per acre.

Mangolds.

Nitrate of Soda pays well for roots if applied at the rate of from 150 to 200 pounds per acre. Use in two applications about ten days apart, *the first not earlier than July.* The Essex Agricultural Society found by experiment that 12 tons of farmyard manure and 300 pounds superphosphate gave a crop of nearly ten and one-half tons per acre, but when 200 pounds of Nitrate of Soda were added, the yield was increased to over 15 tons. The season was very unfavorable. Three hundred pounds per acre of Nitrate is recommended.

Formulas and Directions.

Turnips and Swedes.

Nitrate is applied for this crop quite in the same manner as for mangolds. Dr. Macadam reported to the Arbroath Farmers' Club a gain of 37 per cent. in yield from the use of 336 pounds of Nitrate of Soda per acre.

An experiment conducted by Dr. Munro, of Downtown Agricultural College, Salisbury, gave a return of nearly twenty and one-half tons per acre, from an application of 600 pounds of Nitrate per acre, supplemented by phosphoric acid and potash. The

Increased Yield.

Nitrate was used in three applications. An application of 300 pounds of Nitrate resulted in a yield of thirteen and one-third tons per acre.

Catch-Crops.

Catch-crops are recommended to prevent losses of available plant food after crops are removed. Rape, Italian rye grass, Rye, Thousand-headed kale and clovers are suitable. All these should be top-dressed with from 100 to 200 pounds per acre of Nitrate of Soda, depending upon the exhaustion of the soil. In the remarks on the use of Nitrate in this sketch, we have taken it for granted that our readers fully understand that Nitrate alone is not a complete plant food. In all cases where Nitrate has been recommended, phosphoric acid and potash are to be used, unless the soil contains ample supplies of both.

Wheat and Oats, Rye and Barley.

(Bulletin 44, Georgia Agricultural Experiment Station.)

Nitrate and Cotton-seed Meal Compared on Wheat.

This bulletin gives in detail the results of experiments on wheat with fertilizers, in which Nitrate of Soda is compared with cotton-seed meal; in all cases the plots were liberally supplied with phosphoric acid and potash. The average yield of four plots in each instance amounted per acre to 49.4 bushels for Nitrate of Soda, and 40.1 bushels for cotton-seed meal, a gain for Nitrate of Soda of over 23 per cent. A similar experiment with oats gave a return of 60 bushels for Nitrate of Soda and only 42 bushels for cotton-seed meal, a gain for Nitrate of nearly 43 per cent. The Bulletin recommends, even when cotton-seed meal is used in the complete fertilizer, to employ Nitrate of Soda as a top-dressing in the spring.

Three hundred pounds per acre more Wheat, Oats, Rye or Barley may be raised for each 100 pounds of Nitrate of Soda used as a top-dressing on the soil. Frequent trials at Agricultural Experiment Stations the world over fully prove this to be so.

Barley.

This crop does best on a strong clay loam, but the soil must not be rich in organic matter. Soils naturally rich in

ammoniates are unfavorable, as one of the most important points in high-grade barley is a complete maturity of the grain. With soils rich in vegetable matter, the supply of the only digestible ammoniate or what is exactly the same thing, Nitrated ammonia as Nitrates, continues so late in the season that maturity is retarded seriously. About 400 pounds per acre of fertilizer should be applied broadcast before seeding. As soon as the grain is "up," top-dress with 200 pounds of Nitrate of Soda per acre. If the soil is very rich, apply 100 pounds of Nitrate.

Buckwheat.

This crop does well on almost all kinds of soil, but should follow a grain or hoed crop—that is, a clean cultivation crop. On thin soils use about 400 pounds of fertilizer to the acre, applied just before seeding, or even with the seed. Heavy soils do not require fertilizing for this crop, as it has exceptional foraging powers, and will find nourishment where many grain crops will starve. As soon as the plants are well above ground, apply a top-dressing of 200 pounds of Nitrate of Soda per acre, both on strong and light soils. Use one bushel of seed per acre on thin soils, but a heavier application on richer soils.

Oats.

This grain does well on nearly all types of soil, but responds freely to good treatment. There is a vast difference in the quality of oats when grown on poor or rich soils. Perhaps no other crop so effectually conceals impoverishment; at the same time the feeding value of oats grown on poor soil is very low. In the North oats are sown in the spring, and usually after corn or a turned down clover sod. In such cases the crop is rarely ever given fertilizer, but shows an excellent return for a top-dressing of 100 pounds of Nitrate of Soda per acre. The crop has strong foraging powers, and will find available mineral plant food where a wheat crop would utterly fail. On soils pretty badly exhausted, an application of 500 pounds of fertilizer will yield a profitable return, provided the top-dressing of Nitrate is not omitted. Under any condition of soil or

200 lbs. Bone Dust and eight loads of Stable Manure per acre. Yield, 30 bushels per acre.

1,000 lbs. Lime, 400 lbs. Acid Rock, 200 lbs. Muriate of Potash and 100 lbs. Nitrate of Soda per acre. Yield, 60 bushels per acre.

fertilizing, a sickly green color of the young crop shows need of Nitrate of Soda plant food, and the remedy is a top dressing of Nitrate. In seeding, use two or three bushels to the acre.

Formulas for Oats:

For One Acre.		
Acid phosphate (at sowing time).......	200 lbs.	
Muriate of potash (at sowing time)....	100 "	Ideal Formula
Nitrate of Soda (in the spring)......	100 "	for Oats.
	400 lbs.	

Rye.

This is another illustration of the necessity of care in the use of fertilizer Nitrogen (ammoniate). Rye does best on lighter soils so long as they are not too sandy, but if the soil is rich in vegetable matter, or if a fertilizer is used containing much organic ammoniate, the grain yield will be disappointing; the crop fails to mature in season because the Nitration of organic matter is greatest during the warm days of midsummer, and a constant supply of available

Nitrate is being furnished at a time when the crop should commence to mature. The crop needs Nitrated ammonia, but it should have been supplied during the earlier stages of growth. Use at first a fertilizer, 500 pounds per acre. Top Dress as soon as the crop shows growth in the Spring with 100 pounds of Nitrate of Soda to the acre, broadcast.

Wheat.

The soil for this grain, fall planting, ranges from a clay loam to a moderate sandy loam. For spring wheat, moist peaty soils are used. Wheat is usually grown in rotation, in which case it nearly always follows corn, or a clean culture crop. The nature of cultivation is too well known to require mention here. Both spring and winter wheat are commonly fertilized crops, particularly the latter. The average fertilizer for wheat should contain Ammonia (Nitrogen), phosphoric acid and potash. This fertilizer is applied with the seed, and at the rate of 500 pounds to the acre. Nitrate of Soda is also applied as a top-dressing as soon as the crop shows green in the spring, broadcast, at the rate of 100 pounds per acre. Like all grains, wheat should have its ammoniate plant food early, and in the highly available, easily digested Nitrated form, such as is only to be found commercially as Nitrate of Soda.

The plant food needs of a crop of 30 bushels of wheat per acre amounts to about 70 pounds of ammonia, 24 pounds of phosphoric acid, and 30 pounds of potash; this includes the straw, chaff and stubble. One hundred pounds of Nitrate of Soda supply about 20 pounds of Nitrated ammonia, so that the quantity mentioned for top-dressing is a minimum quantity. Much has been said of legume ammonia for wheat, the crop being generally grown in rotation. Whatever ammonia the clover may have gathered,

a crop of timothy and a crop of corn must be supplied before the wheat rotation is reached. In many cases, simply top dressing with the Nitrate will be found effectual. In all cases where the acre yields have fallen off, top-dressing of Nitrate of Soda should be applied.

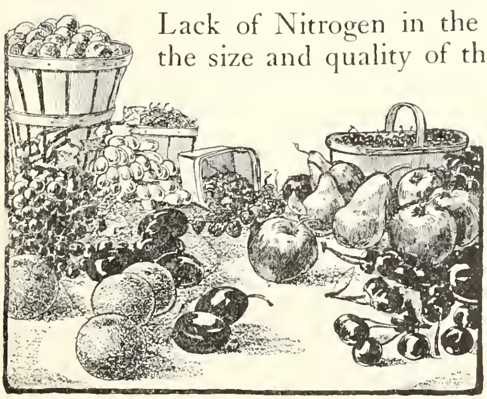
Professor Maercker states that Nitrate of Soda for wheat is absolutely necessary under the conditions in Germany, and that 100 pounds of Nitrate of Soda produces 300 to 400 pounds of grain and a corresponding amount of straw.

An Ideal Fertilizer Formula for Wheat.

Acid phosphate (at sowing time)	300 lbs.
Muriate of potash (at sowing time)	100 "
Tankage (at sowing time)	100 "
Nitrate of Soda (in the Spring)	100 "
Per acre	600 lbs.

FERTILIZERS FOR FRUITS.

(Bulletin 66, Hatch Experiment Station.)



Lack of Nitrogen in the soil is detrimental to the size and quality of the fruit. The cheapest and most available Ammoniate is Nitrate of Soda. A few cents worth applied to each tree will give the largest possible yield of choicest fruit, returning many times its cost.

Nitrate of Soda on Apples.

Fertilizers for the Apple: The results show the most improvement where Nitrate of Soda was applied. For apple trees in grass the following fertilizer is recommended: Nitrate of Soda 1 to 5 pounds, Sulphate of potash 1 to 5 pounds, S. C. phosphate rock 4 to 10 pounds; the quantity used to be varied according to the size of the tree.

Peaches.

Fertilizers for the Peach: The fertilizer recommended, depending upon the size of the trees, is substantially the same as for apples, except that

the phosphate rock is reduced one-half for the earlier stages of growth, remaining the same as for apples in the later stages. Nitrate of Soda should not be applied until just as the trees are beginning to grow.

Nitrate of Soda for Fruits Generally.

Fertilizers for other Fruits: For all perennial fruits as well as shrubs and plants, the fertilizer used should be largely available in the early part of the season, as a preventive to winter injuries. Nitrate of Soda is the most desirable form of ammoniate.

General Fruit Formula per Acre.

300 lbs. Nitrate.
500 lbs. Acid Phosphate.
200 lbs. Sulphate of Potash.

The rational fertilization of fruit trees depends somewhat upon their period of growth; young trees need ample supplies of Nitrate and potash to develop and ripen new wood. Later, at the bearing age, phosphoric acid and Nitrate is required for the formation of fruiting buds. These two phases in the making of an orchard should have due consideration and plant food used accordingly.

How Nitrate Benefits the Farmer.

What Nitrate Looks Like; Its Chemical Properties.

Nitrate of Soda, from the standpoint of the Agricultural chemist, is a substance formed by the union of nitric acid and sodium oxide. In appearance it resembles coarse salt. In agriculture and the arts, it is valuable chiefly for the active Nitrogen (commercially it is an ammoniate package) contained in the Nitrate of the compound; the Soda acts as a carrier of Nitrogen in a combination that can be handled. When pure it contains 16.47 pounds of Nitrogen per 100 pounds of Nitrate of Soda, that is, 16.47 per cent. Nitrogen. Commercially pure Nitrate contains about 15.75 of Nitrogen, equivalent to 19 per cent. of Ammonia, or 380 pounds to the ton.

What it is in Agriculture.

Nitrate of Soda is found mixed with earth in the arid section of northern Chili. It is extracted by means of hot water, in which Nitrate is soluble. The enormous explosive industry of this country could not be conducted without Nitrate of Soda, and glass works are dependent upon it. In fact, glass works and powder works usually have Nitrate on hand.

Where it is Found.

Its Uses.

Nitrate of Soda has a special bearing on the progress of modern agriculture; in the first place it is the most nutritious form of Nitrogenous or ammoniate plant food, and secondly it is a very important factor in the manufacture of sulphuric acid and acid phosphate. *While the action of micro-organisms with certain crops (legume) combines and makes effective use of the inert Nitrogen of the atmosphere, such action is far too slow and uncertain for all the requirements of modern agriculture.* The rapid exhaustion of combined Nitrogen has several times been noticed by eminent scientific men, with reference to food famine, because of a lack of the needful Nitrogenous plant food. It has been estimated under the present methods of cropping the rich lands of our Western States, that for every pound of Nitrogen actually used to make a wheat crop, four to five pounds are utterly wasted. In other words, our pioneer agriculture has proceeded as though Fertility Capital could be drawn upon forever.

Its Position in Modern Agriculture.

Wasteful Methods by our Pioneer Farmers.

This injudicious waste is already reducing the yield of many of the best lands, rendering the use of 100 pounds of Nitrate per acre both profitable and necessary.

The agricultural value of Nitrate of Soda has had the attention of the foremost agricultural and scientific specialists of the world, including such men as Dr. Paul Wagner and Professor Maercker, of Germany; Lawes and Gilbert, Sir William Crookes, Dr. Dyer and Dr. Voelcker, in England; Professors Erandeau, Cassarini, Migneaux, and Cadoret, in France; Professors Bernardo, Giner and Alino, in Spain; and Drs. Voorhees, Wheeler, Kilgore, Brooks, Duggar, Stubbs, Ross, Patterson, Hilgard and Shaw, in America.

Eminent Scientists the World Over Well Acquainted with the Great Value of Nitrate.

The results obtained by these officials may be summarized as follows:

1. Nitrate of Soda acts very beneficially and with great certainty upon all straw-growing plants.

2. It is of special value for forcing the rapid development and early maturity of most garden crops.

3. It is of great importance in the production of sugar beets, potatoes, hops, fodder crops, fibre plants, and tobacco.

4. It is exceedingly valuable in developing and maintaining meadow grass and pasture lands.

5. In the early stages of development it produces favorable results upon peas, vetches, lupines, clover, and alfalfa.

6. It has been applied with much advantage to various kinds of berries, bush fruits, vineyards, orchards and nursery stock, and small fruits generally.

7. It provides the means in the hands of the farmer, for stimulating his crops so that they may better withstand the ravages of drought, or the onslaughts of plant diseases or insect pests, such as boll weevil, etc.

Top-Dressing.

8. It may be used as a surface application to the soil, from time to time, as the plants indicate a need of it by their color and growth.

9. It is immediately available, and under favorable conditions its effect upon many crops may be noticed within a few days after its application.

10. It may be used either as a special fertilizer, as a supplemental fertilizer, or as a mixed fertilizer, in combination with other fertilizer ingredients.

11. The best results are obtained from its application when the soil has been treated with ample supplies of available phosphoric acid and potash, or where these are already present in ample quantities in the soil. It should always be remembered that it furnishes but one element of plant food, namely, Nitrogen, but this is the most expensive element of the three essential ingredients; and of the various commercial forms of Nitrogen (ammoniates) Nitrate is the cheapest.

12. Its uniform action seems to be to energize the capacity of the plant for developing foliage and growth. Its action is characterized by imparting to the plant a deep green, healthy appearance, and by causing it to grow rapidly and to put out numbers of new shoots.

13. The immediate effect of an application of Nitrate of Soda, therefore, is to develop a much larger plant growth, and the skillful application of phosphates and potashes must be relied upon to act in combination with this effect, to secure the largest yields of fruits and grain.

14. Under favorable conditions of moisture and cultivation, these effects may be confidently anticipated upon all kinds of soils.

15. All of the plant food contained in Nitrate of Soda is available and existing in a highly soluble form. The farmer should understand that it is not economical to apply more of it than can be utilized by the growing crop; one of the most valuable qualities of this fertilizer being that it does not lie dormant in the soil from one season to the next.

16. The best results are secured when it is applied during the early growing periods of the plant. *If applied later in the development of the plant, it has a tendency to protract its growing period and to delay the ripening of the fruit, as the energies of the plant are immediately concentrated upon developing its growth, after a liberal application of Nitrate of Soda.*

17. The farmer must not expect it to excuse him from applying proper principles of land drainage, or cultivation of the soil, nor should Nitrate of Soda be used in excessive quantities too close to the plants that are fertilized with it. For most agricultural crops, an application of 100 pounds to the acre is sufficient when it is used alone.

18. It may be applied to either agricultural or garden lands in the form of a solution in water, or by sowing it broadcast upon the land, or by means of any fertilizer-distributing machine in use. If applied in the dry state, in order to insure uniform distribution, a convenient method is to mix it with twice its weight of air-slacked lime, land plaster, phosphates, or even with dry sand, before applying it. It can be applied to the surface, and without cultivation will be absorbed by the soil, or it may be cultivated into the soil by some light agricultural implement, such as a harrow, weeder, cultivator or horse hoe. The capillary movement of the soil waters will distribute it in the soil.

Accepting the conclusions of these scientific men, the use of Nitrate of Soda in agriculture ought to be increased proportionate to the dissemination of the knowledge of its

Its Use Ought to Increase.

usefulness among our farmers. We ought to expect especially an increase in the consumption of Nitrate among growers of tobacco, fibre plants, sugar beets, the hop, grape, grass and small fruits. The element of plant food first exhausted in soils is Nitrogen, and in many cases a marked increase in crop is obtained through Top-Dressings of Nitrate alone. "Complete" fertilizers are generally rather low in ammoniates and Nitrate may be wisely used to supplement them. As it is practically the cheapest form of plant food ammonia, its use in complete fertilizers promises to increase still further.

Nitrate of Soda Niter in Fertilizing.

(Bulletin 24, California State Mining Bureau, May, 1902.)

By Dr. Gilbert E. Bailey.

All plants require light, air, heat, water, cultivation, and a fertile soil. Every crop removes from the soil a portion of the plant-food contained therein, and continuous cropping will, in time, exhaust the richest soil, unless the nutritive elements are restored; therefore, the truly economical farmer will feed the growing plant or tree with a generous hand. The literature on this subject is so scattered as to be difficult of access to the general reader, and the following notes are added in order to give some general idea of the value of Nitrate of Soda in fertilizing.

The most important materials used to supply Nitrogen, in the composition of commercial fertilizers are Nitrate of Soda and sulphate of ammonia. Nitrate of Soda is particularly adapted for Top-Dressing during the growing season, and is the quickest acting of all the Nitrogenous fertilizers.

Dried blood, tankage, azotine, fish scrap, castor pomace, and cotton-seed meal represent fertilizers where the Nitrogen *is only slowly available*, and they must be applied in the fall so as to be decomposed and available for the following season. Nitrogen in the form of Nitrate of Soda is at

once available during the growing and fruiting season, possessing, therefore, a decided advantage over all other Nitrogen plant-foods.

The following list of materials used as a source of Nitrogen, in making commercial fertilizers, shows the percentage of Nitrogen in each:

	Per cent. Nitrogen.
Nitrate of Soda	15 to 16
Sulphate of ammonia	19 to 22
Dried blood	10 to 14
Tankage	5 to 12
Dried fish scrap	9 to 11
Cotton-seed meal	6 to 7
Castor pomace	5 to 6
Tobacco stems	2 to 3
Bone meal	2 to 4
Peruvian guano	6 to 10
Nitrate of potash	13 to 14
Manures	0.3 to 1.6

The following table shows the number of pounds of Nitrogen removed in one year from one acre by the crop specified:

	Crop.		Nitrogen.
Wheat	35	bushels.	59 lbs.
Rye	30	bushels.	51 lbs.
Barley	40	bushels.	46 lbs.
Oats	60	bushels.	55 lbs.
Corn	50	bushels.	67 lbs.
Buckwheat	30	bushels.	35 lbs.
Potatoes	200	bushels.	46 lbs.
Sugar beets	15½	tons.	69 lbs.
Mangel-wurzel	22	tons.	150 lbs.
Meadow hay	2½	tons, dry.	83 lbs.
Timothy	2	tons, dry.	89 lbs.
Green corn	11½	tons.	85 lbs.
Red clover	2	tons, dry.	105 lbs.
Lucern	8	tons.	113 lbs.
Sugar-cane	20	tons.	153 lbs.
Sorghum	15	tons.	121 lbs.
Cotton	750	lbs., seed.	26 lbs.
Hops	600	lbs., seed.	84 lbs.
Tobacco	1,600	lbs.	89 lbs.
Grapes	2	tons.	32 lbs.
Cabbage	31	tons.	150 lbs.
Cucumbers	25	tons.	86 lbs.
Onions	11½	tons.	72 lbs.
Oranges	10	tons.	24 lbs.

Food for Plants

The following table shows the quantity of fertilizer desirable for one acre, with the percentage of Nitrogen in it. The quantities given are for the average soil, under average conditions, the character and amounts of other plant-foods in the fertilizer not being considered here:

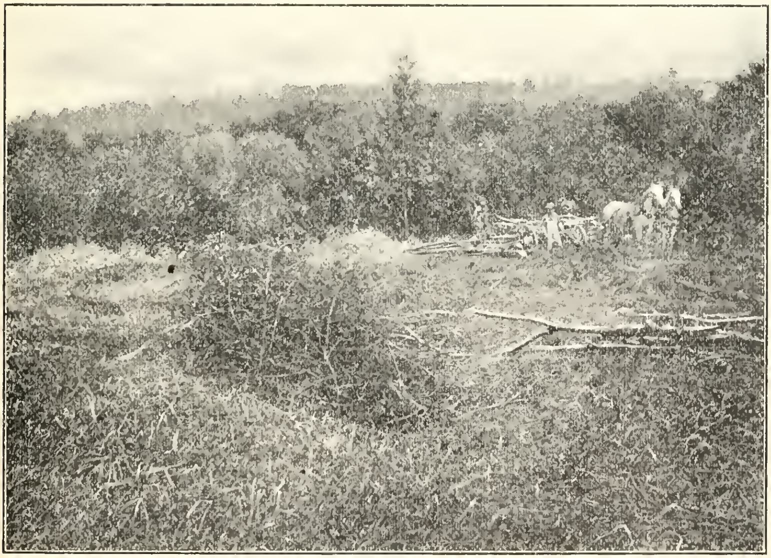
	Fertilizer Nitrate of Soda.	Nitrogen in pounds.		Fertilizer Nitrate of Soda.	Nitrogen in pounds.
	Per acre.	*Per cent.*		*Per acre.*	*Per cent.*
Artichokes	500 lbs.	18	Mint	700 lbs.	28
Asparagus	500	22.5	Mustard	300	9
Barley	300	5	Oats	100	10
Beans	100	14	Onions	300	60
Beets, garden	200	12		*Per tree.*	
Beets, sugar	300	60	Oranges	3	4
Benne	200	27.5		*Per acre.*	
Blackberry	300	19.5	Peas	200	20
Buckwheat	100	9.0	Pineapples	300	50
Cabbage	500	60.0	Potatoes, Irish	150	21
Cane, sugar	300	22.5	Potatoes, sweet	200	22
Carrots	300	15.0	Radishes	240	15
Cassava	300	9.0	Ramie	200	13
Celery	700	28.0	Rape	2,800	24
Corn	150	13.75	Raspberry	300	21
Cotton	100	18.0	Rhubarb	600	29
Cranberry	200	12.0	Rice	300	13.5
Cucumbers	500	36.0	Spinach	180	36.0
Currants	300	16.5	Squash	200	64.0
Egg-plant	400	80.0	Strawberry	300	45.0
Flax	200	12.0	Sunflower	300	60.0
Hemp	200	44.00	Tobacco	600	54.00
Hops	400	30.00	Tomatoes	1,400	36.00
Horseradish	300	24	Trees, general	300	8.00
Lettuce	300	50.0	Turnips	200	2.5
Melons	300	36.0	Wheat	100	3

Chemical fertilizers are used freely by the fruit growers of California, and their use among the farmers is steadily increasing. One reason why they are not used more extensively is that they have to be imported from the East. It is also a fact that the total amount now used is only a small percentage of what should be employed. Every one will admit that the use of fertilizers in this State is small compared with their use in Germany, where they are employed more extensively than by any other nation; yet Dr. Maercker,

the Director of the Government Agricultural Experiment Station at Halle, Germany, says: "Just think! the fertilizer consumption of potash alone in Germany must increase 700 per cent. before the normal demands of the lands and farms are met and satisfied."

Grass Growing for Profit.

Timothy and related grasses feed heavily on Nitrogen; they are able to transform it completely into wholesome and digestible animal food. When full rations of plant food are present a good crop of grass will remove about the equivalent of the active fertilizer ingredients of 300 pounds of Nitrate of Soda, 200 pounds muriate of potash and 400



Clearing Land for Seeding.

pounds of Thomas Phosphate Powder. These amounts are recommended to be applied per acre as top-dressing for grass lands; and if wood ashes are available 200 pounds per acre will be very beneficial in addition to the above. Grass lands get sour easily, especially when old, and when they do, one ton of lime per acre should be harrowed in before

seeding down anew. The seeding must be done before September, and the above-mentioned ration should be used as a top-dressing the following spring, as soon as the grass begins to show growth.

If all the conditions are favorable from three to five tons of clean barn-cured hay, free from weeds, may reasonably be expected. When grass crops are heavy and run as high

Types of Characteristic Rock Shattering (1).

as $4\frac{1}{2}$ tons per acre field-cured, it is safe to allow 20 per cent. shrinkage in weight for seasoning and drying down to a barn-cured basis. Nitrate of Soda, the chief constituent of the prescribed ration, pushes the grass early and enables it to get ahead of all weeds, and the crop then feeds economically and fully on the other manurial constituents present in the fertilizer mentioned in the formula and present in the soil.

When Nitrate costs about $50.00 per ton and clean hay sells $16.00 per ton the financial results are very satisfactory. Nitrate can sometimes be used alone for a season or two and at very great profit, but a full grass ration is better in the long run for both the soil and crop. *Generally speaking, 100 pounds of Nitrate, if used under proper conditions, will produce an increase of from 1,000 to 1,200 pounds of barn-*

cured, clean timothy hay, the value of which will average from \$8.00 to \$10.00. The cost of 100 pounds of Nitrate is likely to average \$2.30 to \$2.60. *It pays well to use Nitrate liberally on grass lands.*

A reliable, heavy Top-Dressing formula for Grass Lands per acre:

300 lbs. **Nitrate of Soda.**
200 lbs. muriate of potash, or 1,000 pounds of wood ashes.
400 lbs. Thomas slag or Peruvian guano or acid phosphate.

900 lbs.

This illustration was made from the photograph of a field of Timothy. The portion on the left was not, that on the right *was*, fertilized with Nitrate of Soda, 400 pounds to the acre. Every farmer is interested in getting the heaviest possible yield of grass.

Making Two Blades of Grass Grow Where One Blade Grew Before.

Grass is a responsive crop and the part played by mineral chemical fertilizers, as proven in Rhode Island, show the striking effect of Nitrate on yields and feeding quality.

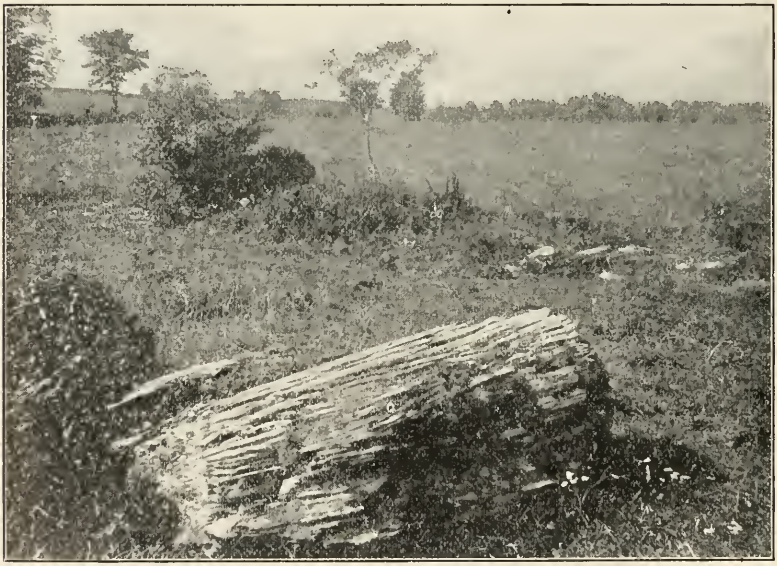
Since all the other fertilizers were alike for the three plats and had been for many years, and since the general character of the soil and the treatments the plats had received were uniform, any differences must be ascribed to the influence of the varying quantities of Nitrate of Soda. These differences, so far as they are shown by the weights of the crops for four years are given in brief below:

Yield of Cured Hay Under Different Rates of Nitrogenous Fertilization.

Nitrate of Soda applied.	Yield of Cured Hay. 1899, Lbs.	1900, Lbs.	1901, Lbs.	1902, Lbs.	Average Yields in Tons.
None	5,075	4,000	3,290	2,950	1.9
150 lbs. per acre*	6,300	5,600	5,550	4,850	2.8
450 lbs. per acre*	6,913	8,200	9,390	8,200	4.1

*Amount slightly reduced in 1901 and 1902.

What the Figures Show. These figures show a uniform, consistent and *marked advantage from the use of Nitrate Nitrogen;* and the effect of its absence is shown by the steady decline of the yields on the no-Nitrate plat from year to year. In each year the use of



Rock before Blasting with One Pound of Forty Per Cent. Dynamite.

150 pounds of Nitrate gave increased yields over the plat without Nitrogen, the gain varying from 1,200 to almost 2,300 pounds, an average gain of about seven-eighths of a ton of hay. Three times this amount of Nitrate did not, of course, give three times as much hay, but it so materially increased the yield as to show that it was all used to good advantage except, perhaps, in the second year. This was an exceptionally dry year and but one crop could be cut.

The advantage from the Nitrate showed strikingly in the production of a rapid and luxurious early growth while moisture was still available. This supply of readily soluble food comes just when it is most needed, since the natural change of unavailable forms of Nitrogen in the soil to the soluble Nitrates proceeds very slowly during the cool, moist

Same Rock Shattered by the Explosion of Dynamite.

weather of spring. The full ration of Nitrogen, 450 pounds of Nitrate, more than doubled the yield of hay over that produced on the no-Nitrate plat in 1900 and in the next two years it nearly tripled the yield. The average increase over the 150 pound plat was one and three-tenths tons and over the plat without Nitrogen was two and five-eighths tons.

Effect on Quality of Hay.

How Nitrate Improves the Quality of the Hay.

Almost as marked, and certainly more surprising and unexpected, was the effect of the Nitrate upon the quality of the hay produced.

The hay from the plats during the first season was of such diverse character that different ton values

had to be placed upon it in estimating the profit from the use of fertilizers. That from the no-Nitrate plat, since it contained so much clover at both cuttings, was considered worth only $9.00 a ton; the first cutting on the small Nitrogen ration was valued at $12.00 and the second cutting at $10.00; while $16.00 and $12.00 were the values given to the first and second cuttings respectively on the plat receiving the full ration of Nitrate.

But the reduction in the percentage of clover was not the only benefit to the quality of the hay. The Nitrate also decreased the proportion of red top as compared with the finer timothy. This tendency was noticed in the second year, when a count of the stalks on selected equal and typical areas showed 13 per cent. of timothy on the 150 pound plat, and 44 per cent. on the 450 pound plat. In the third year the percentages of timothy were 39 per cent. and 67 per cent., respectively, and in the fourth year the differences were even more marked.

Types of Characteristic Rock Shattering (2).

An Alkaline Soil Necessary for Grass.

Timothy is a grass which will not tolerate an acid soil, and it is probable that the liming given these plats in 1897 did not make them as "sweet" as would have been best for this crop. Now, when Nitrate of Soda is used by plants, more of the nitric acid is used than of the soda and a certain portion of the latter, which is an alkali, is

left to combine with other free acids of the soil. This, like lime, neutralizes the acids and thus "sweetens" the soil for the timothy. Red top, on the contrary, does well on soils which are slightly acid, and so would have the advantage over timothy in a soil not perfectly sweet. With the assistance of the Soda set free from the Nitrate, the timothy was more than

How Nitrate Neutralizes Soil Acids and Sweetens the Soil.

Types of Characteristic Rock Shattering (3).

able to hold its own and thus to make what the market calls a finer, better hay; and since the market demands timothy and pays for it, the farmer who sells hay is wise if he meets the demand.

Financial Profit from Use of Nitrate.

How It Pays.

Frequently more plant food is paid for and put on the land than the crop can possibly use, the excess being entirely thrown away, or, at best, saved to benefit some subsequent crop. This was far from the case in these trials. Indeed, it was found by analysis of the hay that more potash was removed by the crops of the first two years than had been added in the muriate used, consequently the amount applied upon each plat was increased in 1901 and in 1902. The Nitrogen requirement of the crops was found to be slightly less than was supplied in 450 pounds of Nitrate and the amount was

reduced to 400 pounds in 1901, and to 415 pounds in 1902. The Nitrate on the second plat was also reduced in proportion. The phosphoric acid, however, was probably in considerable excess, since liming sets free phosphoric acid already in the soil and so lessens the apparent financial profit; but not to an excessive degree.

Excess of Value of Hay Over Cost of Fertilizers.

Nitrate of Soda applied.	1899.	1900.	1901.	1902.	Average.
None..........	$6.09	$13.42	$12.13	$7.44	$9.77
150 lbs.*.......	14.34	20.37	23.97	16.52	18.80
450 lbs.*.......	19.62	30.40	40.70	32.74	30.86

*Slightly reduced in 1901 and 1902.

Practical Conclusions.

From these striking results it must be evident that grass land as well as tilled fields is greatly benefited by Nitrate, and that it would be to the advantage of most farmers to improve the fertility of their soils by growing good crops of grass, aided thereto by liberal fertilizing.

Top-Dressing Grass Lands.

The application should be in the form of a Top-Dressing, applied very early in the spring in order that the first growth may find readily available material for its support and be carried through the season with no check from partial starvation.

On land which shows any tendency to sourness, a ton to the acre of slaked lime should be used every five or six years. This makes the land sweet and promotes the growth of grass plants of the best kinds.

Lime should be sown upon the furrows and harrowed into the soil. *Top-dressing with lime after seeding will not answer, and, in the case of very acid soils, the omission of lime at the proper time will necessitate re-seeding to secure a good stand of grass.*

Economical and Profitable Practice.

All the elements of fertility are essential so that ordinarily complete fertilizers may be used, Nitrate being used as a Top Dresser, though on some soils rich in phosphoric acid or potash, one or both of these ingredients may be used in small quantity. This is particularly true of phos-

phates after lime has been applied to the soil, since lime aids to set the phosphoric acid free from its natural insoluble combinations.

Grass seems to demand less phosphoric acid than was applied in the test; but it responds with increasing profit to applications of Nitrate of Soda up to 350 pounds to the acre when potash and phosphates are present.

Whole Field, except Center, Fertilized with Fourteen Per Cent. Acid Phosphate, Six Hundred Pounds; Sulphate of Potash, Two Hundred Pounds; Nitrate of Soda, Two Hundred Pounds.
Square in Center of Field had Six Hundred Pounds Acid Phosphate, and Two Hundred Pounds Sulphate of Potash, but *no* Nitrate of Soda.

On such soils as that of these plats, the best fertilizer combination for annual application appears to be:

400 pounds phosphate.
200 pounds muriate of potash.
300 pounds Nitrate of Soda.

No stable manure has been used upon the field under experiment for over twenty years.

The Bulletins of the Rhode Island Agricultural Experiment Station, or Farmers' Bulletin No. 77, published by the United States Department of Agriculture, tells how and

when to use lime. Details of excellent grass experiments, to be found in recent Bulletins issued by the Rhode Island Agricultural Experiment Station, Kingston, Rhode Island, tell about Nitrate of Soda.

Nitrate of Soda as Used in Clark's Grass Cultivation.

It may not be out of place here to mention the fact that Mr. Clark's success in obtaining remarkably large yields of hay for a number of years, an average of 9 tons of cured hay per acre for 11 years in succession, has been heralded throughout the United States. He attributes his success largely to the liberal dressings of Nitrate of Soda which he invariably applies to his fields early in the spring, and which start the grass off with such a vigorous growth as to shade and crowd out all noxious weeds before they get fairly started and which result in a large crop of clean and high priced hay.

How Careful Cultivation May Aid in the Profitable Use of Nitrate.

It is also known that many who have tested his methods have met with failure chiefly because they neglected to supply the young grass plants with a sufficient amount of readily available food for their use early in the spring when it is most needed, and before the organic forms of Nitrogen, which exist in the soil only in an insoluble form and which cannot be utilized by the plants as food, until converted into soluble Nitrates by the action of bacteria in the soil. This does not occur to any great extent until the soil warms up to summer temperature when it is too late in the season to benefit the crops' early spring growth.

It is important that we always bear in mind the fact that our only source of Nitrogen in the soil for all plants is the remnants of former crops (roots, stems, dead leaves, weeds, etc.) in different stages of decomposition, and that in the early spring there is always a scarcity of Nitrogen in the soil in an available form, for the reason that the most of that which was converted into soluble forms by the action of the soil bacteria during the warm summer months of the previous year was either utilized by the plants occupying the ground at that time or has been washed down below the reach of the roots of the young plants by the melting snow and the heavy rains of late winter and early spring.

When we consider the fact that most plants require and take up about 75 per cent. of their total Nitrate Ammoniate during the earlier stages of their growth and that Nitrogen is *the* element most largely entering into the building up of the life principle (or protoplasm) of all plants, it is plain that we cannot afford to jeopardize the chances of growing crops by having only an insufficient supply of immediately available Nitrogen when it is most needed.

Tomatoes.

Tomatoes are successfully grown on all soils, excepting very light sand or a very heavy clay; with irrigation, they may be grown profitably on light sandy soils. The soil must be plowed deeply, and thoroughly worked. It is generally best to buy plants from a reputable grower, unless the crop is planted on a large scale for canning, in which case plants are grown under special instructions of the cannery. The main feature in profitable tomato growing is to maintain a rapid, steady growth. The soil should be kept pulverized at the surface as a mulch, for the crop uses enormous quantities of water. The plants continue bearing until frost, hence the earlier fruiting commences the heavier the crop through simply having a longer period in bearing. Ten tons per acre is by no means an unusual yield, but plant food must be used with a free hand.

The New Jersey Experiment Station made an experiment with different forms of ammoniates on this crop, and the Nitrated ammoniate (Nitrate of Soda) not only produced the largest crops, but also the largest quantity of "early" tomatoes, and the *lowest per cent. of culls*. The yield was twelve per cent. greater than that from sulphate of ammonia, and sixty-eight per cent. greater than that from dried blood. As soon as the plants are well rooted, top-dress with 200 to 300 pounds of Nitrate of Soda per acre, worked into the soil about the plants. Farm-yard manure may be used on this crop when grown for canning, but the results are always doubtful, as a continued stretch of dry weather may injure the crop through drying out the soil by the large quantity of vegetable matter mixed with it. However rich the soil may be, or however freely chemical fertilizers may have been used, the top-dressing of Nitrate

will be found to have increased the fruiting power of the plants, and to have also added to the flavor and color of the fruit.

Formula for Tomatoes:

Nitrate of Soda (in two or more applications)........	400 lbs.
Superphosphate..	400 "
Sulphate of potash....................................	100 "

Tobacco.

The value of tobacco depends so much upon its grade, and the grade so much upon the soil and climate, as well as fertilization, that no general rules can be laid down in tobacco culture. Leaving out special tobaccos, such as Perique, the simplest classification of tobacco for the purposes of this book are as follows: *Cigar.*—Tobacco for cigar manufacture, grown chiefly in Connecticut and Wisconsin. *Manufacturing.*—Tobacco manufactured into plug tobacco, or the various forms for pipe smoking and cigarettes. All kinds of tobacco have the same general habits of growth, but the two classes mentioned have very different plant food requirements.

Cigar tobaccos generally require a rather light soil; manufacturing tobaccos prefer heavy, fertile soils. In either case, the soil must be clean, deeply broken, and thoroughly pulverized. Fall plowing is always practiced on heavy lands, or lands new to tobacco culture. Tobacco may safely be grown on the same land year after year. The plant must be richly fertilized; it has thick, fleshy roots, and comparatively little foraging power—that is, ability to send out roots over an extensive tract of soil in search of plant food. The crop needs of plant food are about 170 pounds of ammonia per acre, 70 pounds of phosphoric acid, and 250 to 300 pounds of potash; on the basis of the chemical analysis of the whole crop. As phosphoric acid is apt to take insoluble and unavailable forms in the soil, the quantity is usually more than doubled. The fertilizers recommended for tobacco vary a great deal, but even with the phosphoric acid double the actual need, the ammonia in the fertilizer should exceed the phosphoric acid.

Fertilizers for tobacco run from two to four per cent. ammonia, eight to nine per cent. available phosphoric acid,

and six to eight per cent. potash, the latter always in the form of sulphate. This fertilizer is used in quantities per acre as low as 400 pounds, and as high as 3,000 pounds. It should always be supplemented by a top-dressing of Nitrate of Soda, along the rows of young plants, ranging from 200 to 600 pounds per acre. Manufacturing tobaccos are particularly benefited by the application of Nitrated ammoniates, of which class of fertilizer chemicals Nitrate of Soda alone is cheap enough for use as plant food. While the production of leaf may be enormously increased by abundant use of this Nitrated ammonia, the other plant food elements should also be used to secure a well matured crop. In the case of cigar tobaccos, Nitrated ammoniates should be used exclusively, as it is difficult to secure a thoroughly matured leaf unless the supply of digestible ammoniate is more or less under control, a condition not practicable with ordinary ammoniates. Should the crop at any time before mid-August take on a yellow, sickly color, Nitrate of Soda should be broadcasted at once, along the rows, and at the rate of 200 pounds per acre. If this broadcasting can be done just before a rain, the results will appear promptly.

Tobacco growing is special farming, and should be carefully studied before starting in as a tobacco planter. For small plantations, the plants are best bought of a regular seedsman. The cultivation is always clean, and an earth mulch from two to three inches in depth should be maintained—that is, the surface soil to that depth kept thoroughly pulverized.

Formula for Tobacco:

Nitrate of Soda	300 lbs.
Superphosphate	100 "
Sulphate of potash ("high grade")	100 "

Sweet Potatoes.

This crop prefers a soil lighter than Irish potatoes, but the preparation of the soil is much the same. It is an underground crop, and must not have to mine room for its roots. It should follow a clean cultivation crop, and be kept very clean itself. Too much ammoniate fertilizer

interferes with the maturity of the crop, producing not only a large crop of useless vines, but also few marketable roots, and those of very poor keeping quality.

On this account, the ammoniate plant food applied should not be of the ordinary kind which becomes slowly available, and continues to supply active Nitrated ammonia later in the season, thus delaying maturity to such extent that the crop is injured by cold weather.

Formula for Sweet Potatoes:

Nitrate of Soda (after slips are rooted) Top-Dressing. .	200	lbs.
Muriate of potash.	100	"
Superphosphate.	200	"

Sugar-Cane.

This is a typical crop of the West Indies, but is also grown successfully in Louisiana and Florida. The Sandwich Islands are also very successful for cane growing. The method of planting, by planting sections of cane, is pretty generally practiced in all sugar cane countries. The soil is generally selected for its natural fertility, but many cane lands fail simply because the humus, ammonia supplying substance, has been cropped out of the soil. The yields per acre are very high, often reaching 100 tons of green cane. With such heavy cropping, the plant food needs are naturally very high—nearly 400 pounds of ammonia (Nitrogen) being actually required per acre. The fertilizer used contains ammonia, phosphoric acid and potash. An excess of phosphoric acid is apt to force an early maturity of the crop, especially if ammonia is lacking. Evidences of a too early maturity should be promptly treated with applications along the rows of 400 to 800 pounds of Nitrated ammoniate per acre—Nitrate of Soda.

If the soil is very rich in organic matters, the crop will fail to mature properly, and while the yield of cane may be great, the actual sugar produced will be low. Nitrated ammoniates have the advantage of furnishing ammonia when the plants need it most. If very rich soils must be used it is best to grow a forage crop on the soil one or two years before planting to cane. The proper care of stubble crops is largely a matter of fertilizing; if fertilizers are freely used,

the life of the stubble will be greatly prolonged. This is particularly true of the Nitrated ammoniates. As potash and phosphates are readily available their use has no restrictions, but ordinary ammoniates cannot well be thoroughly worked into the soil, and they fail in a large measure to reach the crop. The Nitrated ammoniate, Nitrate of Soda, being soluble in water, at once acts effectively.

Sugar Beets.

Select, if possible, a deep mellow loam, or even a sandy loam. The crop should follow a clean cultivation crop, such as corn, with deep fall plowing and cross plowing in the spring. With a hard subsoil a subsoil plow must be used, and used conscientiously. Work thoroughly into the soil at the last harrowing before seeding, 300 pounds of a fertilizer, consisting of 100 pounds high grade superphosphate, 100 pounds fine ground bone and 100 pounds potash, and, *see that the potash is in the form of sulphate, or Canada wood ashes.* As soon as the plants have made two leaves, apply along the rows a top-dressing of 300 pounds of Nitrate of Soda per acre. As in the case of barley, sugar beets must be thoroughly matured, or the percentage of sugar will be low.

Strawberries.

This plant requires a moist soil, but not one waterlogged at any time of the year. A light clay loam, or a sandy loam is preferable. There are several methods of cultivation, but the matted row is generally found more profitable than the plan of growing only in hills. While some growers claim that one year's crop is all that should be harvested before ploughing down for potatoes, as a matter of fact the common practice is to keep the bed for at least two harvests. In selecting plants care should be exercised to see that pistillate plants are not kept too much by themselves, or the blossoms will prove barren. The crop is a heavy consumer of plant food, and the soil cannot be made too rich. Farmyard manure should never be used after the plants are set out, as the weed seeds contained therein will give much trouble, especially as the horse hoe

is of little use in the beds. Use from 400 to 800 pounds of phosphate, applied broadcast immediately after harvest; in the spring, as soon as the strawberry leaves show the bright, fresh green of new growth, and apply broadcast 200 pounds of Nitrate of Soda to the acre.

Soiling Crops.

"Soiling" is rapidly becoming recognized as the most economical method of stock feeding; practically, soiling means keeping stock confined, and using green-cut food. It is now known to be much more economical than pasturing, not only that more stock can be kept per acre, but the feeding results are more profitable. The crops chiefly used are vetches, the clovers, rye, buckwheat, spurry, fodder corn, stock beets, cow peas, etc. A succession of crops should be grown, the earliest in most sections being crimson clover, sown the previous summer, and followed by red clover, corn, etc., and ending with cow peas and the vetches. The Silo is used to store green food for the winter months, fodder corn being most commonly used in the Silo.

A rank growth of forage is required, and the maturity of the crop is not a consideration. The soil should be made very fertile and fertilizers used with a free hand. Farmers can easily test the value of heavy fertilizer applications in soiling, by comparing different parts of the same field, differently fertilized. Apply per acre, just before, or even with the seed, from 400 to 800 pounds of phosphate, and as soon as the plants are well up, top-dress with Nitrate of Soda, using from 300 to 600 pounds per acre, and experience will more often approve the 600 pound application than the 300. Top-dress in quite the same manner for second crops. It is a quick, rank growth of green substance that is wanted, and for this purpose no other form of ammonia is as quick acting as Nitrated ammoniate, or Nitrate of Soda.

Small Fruits.

Under this head we treat of blackberries, currants, gooseberries and raspberries. Strawberries have been treated separately in another part of this book. All these small fruits are commonly grown in the garden, generally

under such conditions that systematic tillage is not practicable. For this reason such plant food essentials as may exist naturally in the soil become available to the uses of the plants very slowly. This is as true of the decomposition of animal or vegetable ammoniates as of phosphates and potashes. Consequently, small fruits in the garden suffer from lack of sufficient plant food. All these plants when planted in gardens are usually set in rows four feet apart, the plants about three feet apart in the rows; about 4,200 plants to an acre. In field culture, blackberries are usually set four feet apart each way.

So far as possible, small fruits should be cultivated in the early spring, and all dead canes removed. Work into the soil along the rows from 300 to 600 pounds of phosphate and potash; when the plants are in full leaf, broadcast along the rows from 200 to 400 pounds of Nitrate of Soda, and work in with a rake. If at any time before August the vines show a tendency to drop leaves, or stop growing, apply more Nitrate. Small fruits must have a steady, even growth; in most cases unsatisfactory results can be directly traced to irregular feeding of the plants. In field culture, the crop must be tilled quite the same as for corn; in the garden in very dry weather irrigation should be used if possible. The yield per acre is very heavy, and, of course, the plants must be given plant food in proportion.

Greenhouse Plant Food.

The use of rotted stable manure as a source of greenhouse plant food has been the custom for so many years that more effective forms of plant food make headway slowly; yet this rotted stable manure has many disadvantages. It always contains more or less weed seed as well as disease germs, and it supplies its plant food in available form very irregularly. Also, by fermentation it materially influences the temperature of the seed bed, a temperature we have no means of regulating. The ammonia it contains is not Nitrated, hence for forcing it cannot be safely relied upon. For greenhouse work, the fertilizer chemicals should be used, such as Nitrate of Soda, acid phosphate, and sulphate of potash. They should always be used in such proportions that 100 pounds of ammoniate Nitrogen are

always accompanied by 30 pounds of phosphoric acid and 70 pounds of actual potash. The quantity to be applied should correspond to about three-fourths of an ounce of ammoniate Nitrogen per square yard of surface; that is, to each square yard of bench, use about 5 ounces of Nitrate of Soda, 3 ounces of acid phosphate and 2 ounces of sulphate of potash. A mixture of these proportions may be dissolved in water and applied in small portions every few days, taking care, however, to cease applications with those plants it is desired to fully mature, as soon as the desired growth is made.

Orange Groves.

Satisfactory results have been obtained in Florida by fertilizing during the cold season. About two months before the period of growth begins, apply for each full grown tree a mixture of 7 pounds of high-grade superphosphate and 7 pounds of sulphate of potash, by working it in the soil; after which one pound of Nitrate of Soda may be sown on the surface. In order to accomplish this application economically, it is well to mix the Nitrate with two or three times the quantity of fine, dry soil before applying. The working of the soil must not be so deep or thorough as to start the growth of the tree. An excess of Nitrate is to be avoided, but the amount mentioned is not too much. All other ammoniates on the market must be converted into Nitrate by weathering and the action of the soil bacteria before they can possibly be available for plant food. Nitrate of Soda is a pre-digested ammoniate, and while there is some danger of loss by leaching, this is easily avoided by the use of small and frequent applications. With sulphate of ammonia the danger is much greater, as it must be converted into Nitrate before it is available as food, and during this comparatively long process may all be lost by rains and leaching.

Dried blood, cotton-seed meal and all other ammoniates, if used in such quantities as to afford an adequate supply of Nitrate, may cause die-back. No disease results from more than this, but the annual growth of leaves of fruit trees added to the fruit makes a total yearly consumption of the plant food essentials much greater than that of any grain crop. The early decay of orchards as well as failure

to set fruit buds, is largely a matter of lack of plant food. Orchards should have Nitrated ammoniates, applied early in the season, *as late supplies of ammonia are liable to cause a heavy setting of leaf buds at the expense of next year's fruit. The ordinary ammoniates are not satisfactory for orchard work,* as they continue to supply available ammonia all through the season; not enough in the early part of the year to properly set the fruit, hence severe dropping; too much late in the year when none is needed and which causes the formation of leaf rather than fruit buds. Apply per acre 300 to 600 pounds of a fertilizer high in phosphates and potash, and top-dress with 200 pounds of Nitrate of Soda at blossoming or just after, followed by an additional Top-Dressing of 100 to 200 pounds per acre some four weeks later. The soil between the trees *should* be regularly tilled much as in corn growing. That it is not generally done is no argument against the value of such cultivation methods.

Nursery Stock.

The soil should be a moderately light loam, somewhat deep and thoroughly worked. It is an advantage if the soil has previously been in corn, or some other clean cultivation crop. Nursery stock should not be planted on turned-under clover stubble. A soil rich in ammoniates produces an overgrowth of wood, which fails to mature. This is caused by continued supplies of natural Nitrate up to the time of frost, and as a consequence new sap wood is continually being formed, only to be killed back in winter. The ammonia in all low grade ammoniates is slowly Nitrated by the action of certain soil organisms, which continue at work so long as there are any ammoniates to work upon, or the soil not frozen. All through the season of growth, more or less Nitrated ammonia is being supplied, which acts to prevent the complete ripening of the summer's growth.

This is a marked evil in growing nursery stock. The wood is not matured and is badly killed back by frost, causing serious disfigurement; also the young trees become too slender and suffer more in transplanting. Apply along the rows a fertilizer consisting of 200 pounds of acid phosphate and 200 pounds of sulphate of potash, at the rate of 400 pounds per acre, and work well into the soil. When

the young trees are in full leaf, apply in the same manner 300 to 400 pounds of Nitrate of Soda to the acre; and, four weeks later, repeat the Nitrate application, using 150 to 200 pounds. This will ensure a rapid growth early in the season with ample time for thorough maturing before cold weather. The Nitrate of Soda supplies only Nitrated ammonia, which is immediately available for the uses of the plant. Nursery stock must be constantly watched for evidences of disease, and prompt action taken when such are discovered.

Melons.

The remarks following upon the profitable fertilizing of melons, applies also to cucumbers, cantaloupes, squashes and similar crops. All these crops do best on a rather light loam, or if heavier soils must be used the drainage should be of the best. The method of growing these crops is too well known to require mention here. They should generally follow a clean culture crop, such as corn, as most of these plants cover the ground between rows so quickly that cultivation is limited to the first few weeks of growth. This is also an argument for a thorough preparation of the soil, deep plowing and deep working in preparing the hills.

As soon as the plants are well started, work into the soil about the hills a few ounces of a Nitrated ammoniate (Nitrate of Soda), a quantity per hill corresponding to 250 to 350 pounds of Nitrate of Soda per acre. If at any time the hills should show a sickly yellow, apply Nitrate at once, however late in the season.

Cucumbers, squashes and cantaloupes should be planted in hills 5 feet apart each way, watermelons in hills 10 feet apart each way. On very light soils, heavy rains are apt to leach out available plant food, a result soon followed by a yellowing of the stem of the plants. This is invariably a sign of a lack of Nitrated plant food. Level culture rather than ridges seems to be found more generally successful.

Formula for Melons:

Nitrate of Soda (in two or more applications)........	800	lbs.
Superphosphate..................................	800	"
Muriate of potash................................	200	"

Potatoes.

As is well known this crop must have a deep mellow soil, inclining more to sand than clay. The soil must be fined to a considerable depth, and kept free of weeds throughout the growing season. The most successful growers use only commercial fertilizers, and the amounts applied per acre range from 200 pounds to 1,000 and even 2,000. The fertilizer used should be high in potash, and this potash should be of such form as to be free or nearly free of chlorine, such as sulphate of potash. Early potatoes have a short season of growth, and the Nitrating action in the soil is insufficient to keep up a high pressure of growth during the earlier weeks. *For this crop Nitrate of Soda is indispensable*, top-dressing along the rows as soon as the plants are well above the ground and at the rate of 200 pounds per acre. For fall potatoes, an application of 50 to 100 pounds of Nitrate will be sufficient.

Heavy yields of potatoes can be secured only with good seed. Many of the most successful growers cold-storage their seed potatoes, that the vitality of the seed may not be reduced by freezing and thawing during winter. Seed should be cut to two or three "eyes," and only tubers of the best quality used. The rows should be about three feet apart, and the seed dropped fifteen inches apart in the rows.

Formula for Potatoes:

Amount of Fertilizer Used Per Acre.

Nitrate of Soda	200 lbs.
Muriate of potash	100 "
Superphosphate	300 "

Hops.

A Record of Four Years' Experiments with Hops.

The experiments were conducted at Golden Green, Hadlow, near Tunbridge, England, and under the supervision of Dr. Bernard Dyer. Seven plots were arranged, all except No. 7 receiving equal and ample quantities of phosphoric acid and potash, but varying amounts of Nitrate of Soda, and (plot 7) thirty loads of stable manure. The fertilizing of the plots, and the average crop, kiln dried hops

per acre, with the percentage of gain over the plot not treated with Nitrate, are shown in the following table:

Plot and Fertilizer.		Kiln Dried Hops.	Gain Per Cent.
1	No Nitrate	9.75 cwt.	—
2	2 cwt. NITRATE	12.00 "	23
3	4 " "	13.67 "	39
4	6 " "	13.75 "	41
5	8 " "	14.58 "	49
6	10 " "	14.58 "	49
7	30 loads manure	10.25 "	5

The results show a material gain in the crop from the use of Nitrate of Soda, but the applications on plots 5 and 6 are perhaps greater than will prove economical. The quality of the crop was given exhaustive examination, with the results that plots 2, 3, 4 and 7 graded all the same, and the highest. The quality on the other plots was not materially different. As a result of the investigation, Dr. Dyer recommends Nitrate of Soda strongly for hop growing, but suggests early applications.

Formula for Hops:

Nitrate of Soda	600 lbs.
Acid phosphate, 200 lbs., or Thomas slag	300 "
Sulphate of potash, 100 lbs., or unleached wood ashes	400 "
Lime	100 "

Corn.

The crop is especially adapted for making use of roughage of all sorts. It has a long season of growth and makes its heaviest demand for food late in the season when the conditions are such that soil Nitration is at its highest period of development. It is also a deep rooting crop and capable of drawing its food and water from great depths. It needs vast quantities of water, and the tillage must be very thorough that an even earth mulch may be practically continuous. In the early spring it frequently starts off slowly, and on this account should have some help in the form of hill applications of highly available plant food.

Sweet corn is quite a different crop from field corn; it has a much shorter period of growth and should be fertilized much more heavily. The

FERTILIZER PER VINE, OMITTING NITRATE NITROGEN.

3-5 oz. Muriate or Sulphate of Potash per vine, or 34 lbs. per acre.
2 oz. Acid Phosphate per vine, or 113 lbs. per acre.

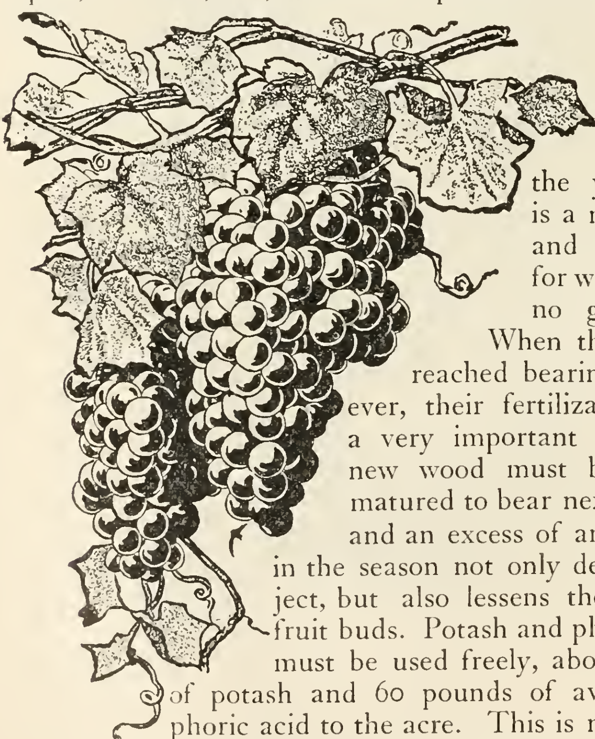
object in this case is not a matured grain, and Nitrate of Soda should be used very liberally in the shape of top-dressings. It is desirable with this crop to guard against a too early maturity, and consequently the available phosphoric acid in the fertilizer should be kept low, not over 120 pounds per ton.

Formula for Corn:

Nitrate of Soda	200	lbs.
Dry ground fish	200	"
Tankage	100	"
Acid phosphate	200	"
Muriate of potash	200	"

Grapes.

Grape plantations should be located and planted by an expert, and one, too, who has experience with the locality



selected as the site of the vineyard. The treatment of the young plants is a matter of soil and climate, and for which there are no general rules. When the vines have reached bearing age, however, their fertilization becomes a very important matter. The new wood must be thoroughly matured to bear next year's fruit, and an excess of ammoniate late in the season not only defeats this object, but also lessens the number of fruit buds. Potash and phosphoric acid must be used freely, about 50 pounds of potash and 60 pounds of available phosphoric acid to the acre. This is not a crop for ordinary commercial fertilizers. The fertilizer suggested above should be applied in the spring, and at the

FERTILIZER PER VINE, WITH NITRATE NITROGEN.

3-5 oz. Muriate or Sulphate of Potash per vine, or 34 lbs. per acre.
2 oz. Acid Phosphate per vine, or 113 lbs. per acre.
3 1-3 oz. Nitrate of Soda per vine, or 189 lbs. per acre.

same time broadcast along the rows Nitrate of Soda at the rate of 200 pounds per acre. If the plants lose color in spots late in the season, work into the soil about the vine an ounce or so of Nitrate, but this must not be done later than midsummer.

Profitable Fertilization of Grapes.

Summary of Experiments by Prof. Paul Wagner, Director of Darmstadt Agricultural Experiment Station, Darmstadt, Germany.

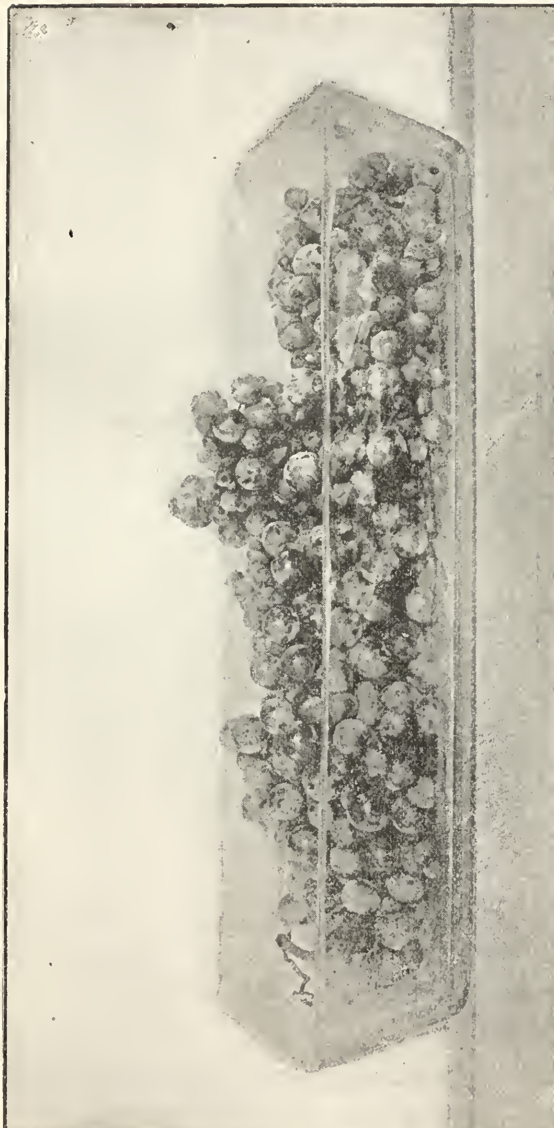
Systematic fertilizer experiments with grapes have been conducted in this country so rarely that we must seek information in this line from foreign experimenters. The experiment detailed below was conducted by Professor Paul Wagner, of the Darmstadt Agricultural Experiment Station, Darmstadt, Germany. The vines were grown singly in pots. The fertilizer application in the two pots illustrated herewith were at the rate of 3.3 ounces of Nitrate of Soda, .6 of an ounce muriate of potash and 2 ounces acid phosphate per vine. At the rate of 907 vines per acre (vines 6 by 8 feet) this application is the equivalent of 189 pounds Nitrate of Soda, 113 pounds acid phosphate and 34 pounds muriate of potash per acre. The accompanying illustrations show the growth of vine and also the production of fruit from the two pots, and the excellent effect of Nitrate of Soda is unmistakably shown. The actual yields of fruit were:

	Per Acre.
Potash and acid phosphate without Nitrate of Soda....	1,024 lbs.
Potash and acid phosphate with Nitrate of Soda.......	4,929 "

A remarkable point in this experiment was data to show the growth of leaf and wood for each 100 pounds of grapes, as follows:

	Wood.	Leaf.
With Nitrate, for 100 lbs. grapes..........	47 lbs.	13 lbs.
Without Nitrate, for 100 lbs. grapes.......	119 "	34 "

The evidence tends to confirm the belief that insufficient or improperly balanced fertilizers produce wood and leaf growth often at the expense of the fruit; that is, the merchantable portion of the crop. In fertilizing grapes the phosphate and potash should be applied early in the spring, before the vines begin to grow; Nitrate of Soda should be



Yield of vine fertilized omitting Nitrate Nitrogen, 1.13 lbs. of grapes.

applied just at the time the vines commence growth in the spring. A better plan perhaps is to apply the Nitrate in two doses, one when the vines start growth in the spring, the second some time three weeks later.

Lawns and Golf Links.

Lawns and Golf Links. Good lawns are simply a matter of care and rational treatment. If the soil is very light, top-dress liberally with clay and work into the sand. In all cases the soil must be thoroughly fined and made smooth, as the seed, being very small, require a fine seed bed. In the South seed to Bermuda grass or Kentucky blue grass; in the North the latter is also a good lawn grass, but perhaps a little less desirable than Rhode Island bent grass (Agrostis canina). Avoid mixtures, as they give an irregularly colored lawn under stress of drouth or early frosts or maturity. For Rhode Island bent grass use 50 pounds of seed per acre, Kentucky blue grass 40 to 45 pounds, and for Bermuda grass 15 pounds. If for any reason the soil cannot be properly prepared, pulverize the fertilizer very fine indeed. The grass should be mowed regularly and the clippings removed until nearly mid-summer when they are best left on the soil as a mulch. For a *good lawn*, broadcast per acre in the spring enough of a fertilizer to supply 100 pounds of actual potash and 50 pounds of available phosphoric acid; also, use at the same time and in the same manner a top-dressing of 300 pounds per acre of Nitrate of Soda. By the end of June repeat the Nitrate top-dressing, using only 100 pounds of the material. At any time through the growing season, yellow spots or lands should be given a light top-dressing of Nitrate, and thoroughly wet down if possible. Lawns are very different from field crops as they are not called upon to mature growth in the line of seed productions, and they may safely be given applications of Nitrate whenever the sickly green color of the grass appears, which shows that digestible or Nitrated ammonia is the plant food needed. These applications of plant food must be continued each year without fail, and all bare or partly bare spots well raked down and reseeded. If absolutely bare, these spots should be deeply spaded. On very heavy clay soils, and in low situations, a drainage system must be established.

Yield for fertilized vine, with Nitrate ration, 5.45 lbs. of grapes per vine.
Increased yield due to the use of Nitrate of Soda, 400% over yield of fertilized vessel omitting Nitrogen.

How Money Crops Feed.

What the Food Is.

The substance of plants is largely water and variations of woody fiber, yet these comprise no part of what is commonly understood as plant food. More or less by accident was discovered the value of farmyard manures and general farm refuse and roughage as a means of increasing the growth of plants. In the course of time, the supply of these manures failed to equal the need, and it became necessary to search for other means of feeding plants. The steps in the search were many, covering years of careful investigation, and it is needless to go into a lengthy description here; but, as a result we have the established fact that the so-called food of plants consists of three different substances, *Ammonia* (Nitrogen), *Potash* and *Phosphates.*

Its Principal Elements, Nitrate Ammonia, Phosphoric Acid, Potash.

These words are popular names, and are used for the convenience of the general public. As a matter of fact, plant-food ammonia is not real ammonia, but ammonia combined with other elements, yet the valuable factor is always the ammoniate. Nitrate of Soda contains an amount equivalent to about nineteen per cent. of ammonia, or 380 pounds to the ton, and cotton-seed meal, for example, about nine per cent.; as plant food more than two pounds of cotton-seed meal are necessary to furnish as much plant food as one pound of Nitrate of Soda. We value the plant food on the amount of ammoniate it contains, and on this account ammonia has become a popular standard name for this element of plant food. In like manner, Phosphoric Acid and Potash are standards, hence the importance of farmers and planters in familiarizing themselves with these expressions. We always think of fertilizers and manures as just so much Ammonia, Phosphoric Acid and Potash, as we can then at once compare the usefulness of all fertilizer materials. No doubt other substances are necessary for the proper development of crops, but soils so generally supply these in ample quantities that they may safely be neglected in a consideration of soil needs and plant foods. The food of plants may therefore be understood to mean simply, *Ammonia, Phosphoric Acid* and *Potash.*

Why Farmyard Manure and Other Products are Valuable.

Farmyard manure acts in promoting plant growth almost wholly because it contains these three substances; green manuring is valuable for the same reason and largely for that only. Various refuse substances, such as bone, wood ashes, etc., contain one or more of these plant food elements, and are valuable to the farmer and planter on that account. A number of crude chemicals contain Ammonia, or Potash, or Phosphoric Acid, or some two of these, or even all three of the plant food elements, and are valuable to agriculture accordingly. In fact, in whatever form, state or condition this plant food occurs, crops seem to be able to make a more or less ready use of it. However, the manufacturer, the farmer and the planter must not overlook the fact that *all three* of these elements are needed. No excess of any one, nor of any two, can make up for the deficiency of any one. To illustrate, should a soil be given enough Phosphoric Acid and Potash for a crop of 80 bushels of corn per acre, but only enough Nitrate Ammonia for 40 bushels, the yield cannot go above 40 bushels. The chain is no stronger than its weakest link.

All Three Elements Indispensable.

The Quality of Manures and Fertilizers.

Nitrate a Pre-digested Ammoniate.

While plant food is always plant food, like all other things it possesses the limitation of quality. Quality in plant food means the readiness with which plants can make use of it. In a large sense, this is dependent upon the solubility of the material containing the plant food—not merely solubility in water, but solubility in soil waters as well. Fertilizer substances freely soluble in water are generally of the highest quality, yet there are differences even in this. *For example, Nitrate of Soda is freely soluble in soil liquids and water, and is the highest grade of plant food ammoniate;* sulphate of ammonia is also soluble in water, but of distinctly lower quality because plants always use ammonia in the Nitrated form (the form in which it occurs in Nitrate of Soda), and the ammonia in sulphate of ammonia must be Nitrated before plants can make use of it.

This is done in the soil by the action of certain organisms, under favorable conditions. The weather must be suitable, the soil in a certain condition; and, besides, there are considerable losses of valuable substance in the natural soil process of Nitrating the ammonia. By unfavorable weather conditions, or very wet or acid soils, Nitration may be prevented until the season is too far advanced, hence there may be loss of time, crop and money.

Defects and Losses in the Use of Ordinary Ammoniates.

The quality of ammoniates, such as cotton-seed meal, dried fish, dried blood, tankage, etc., is limited by conditions somewhat similar to those influencing sulphate of ammonia, except that the crude materials are not even soluble in water. With these substances, the loss of Nitrogen in its natural soil conversion into Nitrate is very great. Perfectly authentic experiments and made under official supervision, have shown that 100 pounds of ammonia in these organic forms have only from one-half to three-fourths the manurial value of 100 pounds of Nitrate Ammonia in its Nitrated form of Nitrate of Soda.

Intrinsic Values of Ammoniates Based on Nitrate as the Standard.

This matter of fertilizer quality is not confined to ammoniates. Potash also must be in soluble form, but as most agricultural potash is in the shape of potash salts, all of which are water soluble, the solubility of potash is not a problem in manuring. However, there are grades even in these salts. For some crops materials containing *muriates* are thought to be injurious, therefore potash in such forms as are free of chlorine or muriates are of higher grade than those containing chlorine.

Phosphates, Potashes.

Special Functions of Plant Food.

As stated before, plants must have all three—Nitrate, Phosphates and Potash—of the plant food elements, but notwithstanding this imperative need, each of the three elements has its special use. This may seem of little importance if for mere growth all three must be used in any event. However, there are many cases in which considerations of the special functions of plant food elements become

Unusual Functions of Nitrate.

important. For example, a soil may be rich in organic ammonia from vegetable matter turned under as green manure, and through a late wet spring fail to supply the available Nitrate in time to get the crop well started before the hot, dry summer season sets in. In this case the use of a Nitrate ammoniate alone in the highly available form, such as Nitrate of Soda, will force growth to the extent of fully establishing the crop against heat and moderate drouth. This method of manuring is simply Top-Dressing, familiar to us all, but which many of us do not fully understand.

Use of Acid Phosphate.

In like manner, if the soil is too rich in organic ammoniate, which during the summer months rapidly becomes available, and as the fall approaches, the crop fails to show signs of manuring, liberal top-dressing of acid phosphate will hasten the maturity of the crop. All soils contain more or less plant food as a natural condition, but this plant food is rarely economically balanced for the uses of the farmer or planter. If crops show a tendency to lodge badly, potash is needed. In many ways, in fact, the special functions of the plant food elements are important, and should have the careful attention of those who have to deal with the plant food problem. There is no "royal road" to the understanding of the fertilizer or manure questions; they must be "worked out."

Special Influence of Nitrate on Edible Value of Plant.

Nitrated ammonia as plant food seems to influence more especially the development of stems, leaves, roots, etc., while the formation of fruit buds is held in reserve; in fact, the growth of the framework of the plant. This action is of course a necessary preliminary to the maturity of the plant, and the broader the framework the greater the yield at maturity. The color of the foliage is deepened, indicating health and activity in the forces at work on the structure of the plant. Nitrates also show markedly in the economic value of the crop; the more freely Nitrates are given to plants the greater the relative proportion in the composition of the plant itself, and the most valuable part of all vegetable substance for food purposes at least, is that containing the greatest proportion of combined and modified ammonia.

Potash as plant food seems to influence more particularly the development of the woody parts of stems and the pulp of fruits. It is also essential to the formation of sugar and starch. The flavor and color of fruits is also credited to potash. In fact, this element of plant food seems to supplement the action of Nitrogen by filling out the framework established by the latter. Potash with Nitrate is always an important fertilizer with special crops where the object is to produce sugar, starch, or other products usually more or less a result of the manufacture of agricultural produce.

How Nitrate May Be Supplemented by Potash.

Phosphoric Acid as a plant food seems to influence more particularly the maturity of plants, and the production of seed or grain. It seems to aid the assimilation of the other plant food elements. Its special use in practical agriculture is to help hasten the maturity of crops likely to be caught by an early fall, and to supplement green manuring where grain is to be grown. It seems to be used in excess in commercial fertilizers, because it is prone to take insoluble and therefore unavailable forms in the soil.

How Nitrate May Be Aided by Phosphoric Acid.

The natural plant food of the soil comes from many sources, but chiefly from decaying vegetable matter and the weathering of the mineral matter of the soil. Both these processes are somewhat slow except under very favorable conditions, and both supply Potash and Phosphoric Acid, but only the former supplies Nitrate. Whether the soil has been fertilized or not, there are certain signs which indicate the need of plant food more or less early in the growth of the crop. If a crop appears to make a slow growth, or seems sickly in color, it does not greatly matter whether the soil is deficient in Nitrate or simply that the ammoniates present have not been Nitrated and so are not available; the remedy lies in top-dressings of the immediately available form of Nitrated ammoniate, of which class of plant food materials Nitrate of Soda alone is commercially available.

Sources of Natural Plant Food.

How They May Be Supplemented with Profit.

Top-Dressings.

Early Growth of Plants.

Top-Dressing, as commonly understood, means simply the application of plant food after seeding, and after the crop has made some growth. It has various objects, but chief among them is the fact that fall sown crops should make an early start in the spring in order to establish an extensive root system (foraging both for food and water), and to protect the soil by shading before the hot, dry days come. The earlier growth of crops is largely a matter of Nitrate plant food, but in the spring the soil is usually wet and cold, both conditions unfavorable for the action of organisms which convert the stored ammoniate plant food into the Nitrates.

How Nitrate Saves Time, Money, and the Crop.

A very late spring may prevent the natural and usual Nitration of this kind of plant food, though large quantities may have been applied in the form of organic ammoniates and other crude manures, so that the warm weather finds the crop very backward and a full crop cannot be made. An application of Nitrate of Soda, the most quickly available form of ammoniate plant food in commercial use as a fertilizer, *as soon as the crop shows the fresh green color of new growth in the spring, prevents this loss of time and establishes the crop so as to resist drouth and reach and make use of the plant food necessary for the maturity of its stalk and the ripening of its seed.*

Nitrate on Fruits.

Top-Dressings are also made to advantage on fruits and vegetables from which the proportion of valuable produce to stalk or vine is so great. With these crops there must be no check in the regular growth of the plants, and Nitrate of Soda alone insures this. With other forms of ammoniate plant food, rains or cool weather interfere with the regular supply of Nitrate, by checking the action of the organisms which cause the Nitration of crude ammoniate substances. Top-dressings are also used on very rolling lands, in which case the hill tops show lighter colored foliage in prolonged periods of dry weather, and light applications of Nitrate of Soda are found to be profitable.

How all Ammoniates are, of Necessity, Nitrated, and Slowness of the Process.

On heavy clay soils, spring working is impracticable, as it results in puddling the top soil. In this case fertilizers cannot be worked into the soil even for spring planting, and Nitrate of Soda is used in the form of a top-dressing spread broadcast; Phosphoric Acid and Potash are usually applied in the fall for such soils.

How to Top-Dress. In top-dressing soils, it is very important to secure an even application over the whole area. As the ordinary application per acre is about 100 pounds, it is difficult to get an even distribution unless the bulk of the material is increased. The best method of doing this is to crush the Nitrate of Soda thoroughly, and mix carefully with about three times its weight of fine dry loam. This mixture should be made immediately before using, though the Nitrate may be crushed at any time if mixed at once with an equal bulk of fine, clean sand and tightly packed in bags. In the latter case, just before using, mix with an equal weight of dry loam. Where top-dressings are made with a machine, it is necessary that the mixture be dry, so that the feeders will not clog.

Top-Dressing Experiments.

Results of Nitrate on Money Crops. The official Agricultural Experiment Stations have made many experiments to determine the value of top-dressings of Nitrate of Soda, particularly the New Jersey Station. The work of this Station demonstrated the profit value of Nitrate top-dressing on various fruits and vegetables. The Rhode Island Experiment Station made (see Bulletin 71) a top-dressing test on grass land and the results also indicated a profitable use of this chemical fertilizer.

The experiment was made on three plots, all of which were treated with ample quantities of Phosphoric Acid and Potash. One plot received no Nitrate, one plot a top-dressing of 150 pounds per acre, and the remaining plot a top-dressing of 450 pounds of Nitrate per acre. The seed used was one-quarter red clover, one-quarter redtop, and one-half timothy. The yield in barn-cured hay was as follows:

No Nitrate	1.60 tons.
150 lbs. Nitrate	2.24 tons.
450 lbs. Nitrate	3.28 tons.

The season was not good hay weather on account of an early and severe drouth, yet the top-dressing of 150 pounds of Nitrate of Soda per acre increased the crop of hay 40 per cent., and the top-dressing of 450 pounds gave an increase of 105 per cent. *In summarizing the results the Station reports that in spite of weather so unfavorable that there was practically no second crop, a top-dressing of 150 pounds of Nitrate of Soda per acre increased the crop in value $6.94, at a cost for Nitrate of $3.30; a top-dressing of 450 pounds per acre increased the value of the crop $16.98 at a cost of $9.90.*

Plant Food Needs of Crops.

What Crops Take out of Soils.

The chemical analysis of plants shows the actual amounts of ammonia, potash and phosphoric acid they contain, and is a fairly good guide for the composition of fertilizers. The value of plant food, so called, is not solely through its use as simple food, but at the same time there is a fair degree of uniformity in the fertilizer needs of plants as shown by their chemical analysis. At least it is the only practical method of comparison we have. In an examination of the fertilizer requirements of plants by studying their analysis, we must keep in mind the fact that the whole plant must be considered—not only the grain, straw, etc., but also the stubble and roots. While it is true the stubble and roots remain in the soil, there is invariably a considerable loss in the process of transforming crude fertilizing substances into available forms.

The Storrs Experiment Station of Connecticut reported on an experiment with timothy hay, with results as follows:

	Yield per acre.	Ammonia (Nitrogen).	Potash.	Phos. Acid.
Hay..............	3,980 lbs.	39.0 lbs.	51.5 lbs.	13.9 lbs.
Stubble and roots..	8,223 "	90.1 "	55.8 "	25.2 "
Total......	12,203 lbs.	129.1 lbs.	107.3 lbs.	39.1 lbs.

Equivalent Quantity of Nitrate Food.

The quantities of plant food actually contained in the crop, computed to the best known fertilizer materials, are represented by 807 pounds of Nitrate of Soda, 215 pounds of muriate of potash, and 280 pounds of acid-

phosphate. This illustration is interesting as showing the really heavy consumption of plant food by ordinary farm crops. While the yield in this case is a large one, it is precisely such yields all farmers are striving for. It is probably true that an acre application of 800 pounds of Nitrate of Soda would not give a profitable return with this crop; but such crops actually make use of soil Nitrogen and the roughage of the farm, and to do this most effectively, top-dressings of Nitrate are advised to "start the crop off" in the spring.

In actual farming operations, the greater part of the timothy crop will be returned to the soil in the form of farmyard manure, much of which will be applied in the fall. A considerable portion of the ammoniate (Nitrogen) contained in this manure will be converted into Nitrate during the fall and winter, and such of this as the plants fail to take up is dissipated by the spring rains and other causes. Consequently, there is a lack of Nitrate Ammoniate in the early spring, when the plants most need it, and this shortage continues until the soil warms and becomes less charged with water, when the organisms of the soil are enabled to convert the vegetable substance containing ammonia into the form suitable for the uses of the plants. Until this action, the plants really starve for Nitrate; a situation instantly relieved by top-dressings of Nitrate of Soda.

Part Played by Nitrate in Plant Nutrition.

The following table shows the plant food necessary to accompany each 100 pounds of ammonia (Nitrogen) assimilated by crops figured on a fair yield per acre:

Crop.	Ammonia (Nitrogen). Pounds.	Potash. Pounds.	Soda. Pounds.	Phos. Acid. Pounds.
Barley	100	74	—	25
Buckwheat	100	59	—	21
Corn	100	55	—	48
Oats	100	93	—	33
Wheat	100	43	9	34
Onions	100	83	—	42
Potatoes	100	132	2	38
Rye	100	72	—	42
Timothy	100	69	7	26

The figures of the table are based on the complete crop, including stalks, straw, vines, etc. The table shows roughly

the proportions which various crops store within their substance of the three elements of plant food; in estimating the composition of a fertilizer for any of these crops, the table serves as a suggestion.

Suggestions for Top-Dressing Crops.

It must be understood that fertilizers do not take the place of tillage. However thoroughly a crop may be fertilized, without proper preparation of the soil the result must be more or less a failure. In top-dressing it is very important that the Nitrate of Soda be thoroughly ground, that an even distribution can be made; the fertilizer must go to the plant, not the plant to the fertilizer.

The Alfalfa, Cow Pea and Clover Question.

Use of Legumes.

This class of plants has the property of taking inert ammonia (Nitrogen) from the air and transforming it into combinations more or less useful as plant food. This feature is of great value to agriculture, but not so much from the plant food point of view as from the fact that these plants are rich in that kind of food substance commonly called "flesh formers." Liberally fertilized, and not omitting Nitrate in the fertilizer, we have a crop containing more Nitrogenous food (protein or flesh formers) than the Nitrogen actually given as fertilizer could have made by itself. The most common plants of this class are: alfalfa, alsike clover, crimson clover, red clover, Japan clover, cow peas, lupines, Canadian field peas, the vetches, etc. All these forage crops should be sown after clean culture crops. The best method of fertilizing is to apply from 300 to 500 pounds of fertilizer, in the early autumn, and *every* autumn; in the spring, top-dress with 200 pounds of Nitrate of Soda, and repeat with about 100 pounds after each cutting. It is true that clovers *may* supply their own ammoniate plant food, but this is an experiment experienced farmers do not often repeat. A fair green crop of clover, for example, removes from the soil some 160 pounds of ammonia, while in 500 pounds of Nitrate of Soda there are less than 100 pounds. Undoubtedly, the ammonia taken from the air is a great aid, *but we*

should not expect too much of it. The method of seeding clovers depends much upon locality and soil needs with reference to previous crops. Crimson clover and Canadian field peas are usually sown in August, after earlier crops have been removed, or even in corn fields. Red clover is commonly sown in the spring on wheat or with oats.

Cost of Transportation of Fertilizers.

A striking illustration of the difference in the cost of transportation by four different ways is given by Representative Brownlow, of Tennessee, in a recent speech before Congress. Mr. Brownlow is the author of the bill asking for national aid to road improvement and in support of the measure he gave the following table which is based on the most careful estimates:

Cost of Transportation Per Ton.

Horse power, 5 miles	$1.25
Electric power, 25 miles	1.25
Steam cars, 250 miles	1.25
Steamships on the lakes 1,000 miles	1.25

It will be seen that the same amount of money it takes to haul a given amount of produce five miles on a public highway of the United States will pay the freight for 250 miles on a railroad and 1,000 miles on a steamship line on the lakes. This is too great a difference as will be admitted by all, and when we think of the fact that the railroad companies are ever at work repairing and improving their highways while the farmer is apparently so little awake to his own interests in regard to furnishing himself with better roads we wonder why it is. The lesson seems plain and clear and as farmers let us continue to aid the good road movement throughout the country.

Nitrate of Soda is essentially a seaboard article; at the present time facilities for supplies at interior points have not been provided.

In ordering Nitrate of Soda make the request that in the event of purchasing, that it be sent as "Fertilizer," and that it be marked "For Fertilizing Purposes." It has been the custom of the railroad companies to discriminate heavily against Nitrate of Soda by charging almost prohibitory

rates, and it is hoped by correctly designating the material the discrimination will not be practiced.

RETABULATION SHOWS THAT:

$1.25 WILL HAUL A TON—
5 miles on a common road,
12½ to 15 miles on a well-made stone road,
25 miles on a trolley road,
250 miles on a steam railway,
1,000 miles on a steamship.

Farm newspapers generally are quite willing to publish wholesale quotations on all those things which the farmer has to sell, and they have not, as a rule, published wholesale quotations on those articles which he has to buy. Among the latter, agricultural chemicals occupy a position of prime importance, not only as to actual effect on farm prosperity, but as to the actual amount of cash which the farmer has to spend, for his produce comes out of the soil and its amount and quality is determined by the character of the chemicals he puts in it. Agricultural journals generally, which profess to be friends of the farmer should make a continued effort in the direction of enhancing his purchasing power, by endeavoring to make him more prosperous. This cannot be done under old conditions of helping to make him, at the outset, pay such a large bonus for agricultural chemicals under one pretext or another.

As Nitrate is a powerful plant tonic and energizer, *it is NOT a stimulant in any sense of the word;* a very small quantity does a very large amount of work. Evenly Top-Dress by broadcasting the Nitrate as soon as the frost leaves the ground in the spring, or as soon as verdure first appears.

I never recommend the use of Nitrate of Soda alone, except at the rate of not more than one hundred (100) pounds to the acre, when it may be used *without* other fertilizers. The phosphatic and potassic manures should usually be applied in connection with Nitrate of Soda at the rate of about two hundred and fifty (250) pounds to the acre of each. A rate of one hundred pounds (100) per acre you will

generally find profitable for all crops. It will be found quite satisfactory also in its after-effect in perceptibly sweetening sour land.

Orange Groves.

An orange that weighs a pound would sell in New York for a dime. When it takes six to weigh a pound they are worthless.

Satisfactory results have been obtained in Florida by fertilizing during the cold season. About two months before the period of growth begins, apply for each full grown tree a mixture of 7 pounds of high-grade superphosphate and 7 pounds of sulphate of potash, by working it in the soil; after which one pound of Nitrate of Soda may be sown on the surface. In order to accomplish this application economically, it is well to mix the Nitrate with two or three times the quantity of fine, dry soil before applying. The working of the soil must not be so deep or thorough as to start the growth of the tree. An excess of Nitrate is to be avoided, but the amount mentioned is not too much. All other ammoniates on the market must be converted into Nitrate by weathering and the action of the soil bacteria before they can possibly be available for plant food. Nitrate of Soda is a pre-digested ammoniate, and while there is some danger of loss by leaching, this is easily avoided by the use of small and frequent applications. With sulphate of ammonia the danger is much greater, as it must be converted into Nitrate before it is available as food; and during this comparatively long process may all be lost by rains and leaching.

Dried blood, cotton-seed meal and all other ammoniates, if used in such quantities as to afford an adequate supply of Nitrate, may cause die-back. No disease results from the proper use of Nitrate of Soda. Besides the possible losses indicated, when other ammoniates are used, there is an actual loss of Nitrogen during the process of Nitration, and all ammoniates must undergo Nitration—must be Nitrated before living trees or plants will feed on them. From six weeks to two months after the above appli-

cations Nitrate may be used again as above indicated. If desirable, two to three months later a further application of one and a half pounds of Nitrate of Soda and potash may be made. In the case of your particular soil, it may well be that it is sufficiently rich in potash, and therefore, may not require a large application of it. In any event, the grower must be governed by the condition of his grove and the general character of soil and climate in his particular locality.

Strawberries.

Prof. W. F. Massey (all farmers know him) writes: "I top-dressed an old strawberry bed in its fifth year of bearing with 300 pounds Nitrate of Soda per acre. I had intended ploughing it up the previous summer as it was in an exhausted condition and foul with white clover and sorrel.

"The effect was amazing, for this bed of an acre and a quarter, from which I expected almost nothing, gave *seven thousand quarts of berries.*"

This plant requires a moist soil, but not one water-logged at any time of the year. A light clay loam, or a sandy loam, is preferable. There are several methods of cultivation, but the matted row is generally found more profitable than the plan of growing only in hills. While some growers claim that one year's crop is all that should be harvested before ploughing down for potatoes, as a matter of fact the common practice is to keep the bed for at least two harvests. In selecting plants care should be exercised to see that pistillate plants are not kept too much by themselves, or the blossoms will prove barren. The crop is a heavy consumer of plant food, and the soil cannot be made too rich. *Farmyard manure should never be used after the plants are set out*, as the weed seeds contained therein will give much trouble, especially as the horse hoe is of little use in the beds. Use from 400 to 800 pounds of phosphate, applied broadcast immediately after harvest; in the spring, as soon as the strawberry leaves show the bright, fresh green of new growth, apply broadcast 200 pounds Nitrate of Soda to the acre.

Table Showing Prices of Nitrate of Soda on the Ammoniate Basis.

Figured on Basis of 380 Pounds Ammonia in One Ton of Nitrate of Soda.

Price per Cwt. of Nitrate.	Price per Ton of Nitrate.	Price Ammonia per lb. as Nitrate.	Equivalent Price Ammonia per Ton unit.	Equivalent Cost of Nitrogen per lb.
$1.85	**$37.00**	$0.097	**$1.95**	$0.118
1.90	**38.00**	0.100	**2.00**	0.122
1.95	**39.00**	0.103	**2.05**	0.125
2.00	**40.00**	0.105	**2.10**	0.128
2.05	**41.00**	0.108	**2.16**	0.131
2.10	**42.00**	0.111	**2.21**	0.134
2.15	**43.00**	0.113	**2.26**	0.137
2.20	**44.00**	0.116	**2.31**	0.140
2.25	**45.00**	0.118	**2.37**	0.144
2.30	**46.00**	0.121	**2.42**	0.147
2.35	**47.00**	0.124	**2.47**	0.150
2.40	**48.00**	0.126	**2.53**	0.153
2.45	**49.00**	0.129	**2.58**	0.156
2.50	**50.00**	0.132	**2.63**	0.159
2.55	**51.00**	0.134	**2.68**	0.162
2.60	**52.00**	0.137	**2.73**	0.165
2.65	**53.00**	0.140	**2.78**	0.168
2.70	**54.00**	0.143	**2.83**	0.173

This table enables one to compare commercial quotations on ammoniates with accuracy. The figures themselves are not quotations in any sense of the word, and all the figures of the table refer only to one grade of Nitrate of Soda, namely: that containing 15.65 per cent. of Nitrogen, equivalent to 19.00 per cent. of ammonia. It is prepared merely in order that purchasers may compare the price of Nitrate of Soda which is always quoted by the hundred pounds, with the other ammoniates, which are quoted by the ton unit. In the first column, therefore, are given the prices per hundred weight of Nitrate of Soda; in the second

column, the corresponding prices per ton; in the third column, the cost of the contained ammonia per pound, a figure which is always discussed, but almost never explained in Station Bulletins; in the fourth column, the equivalent price of the Ammonia per ton unit, and in the fifth column, gives the corresponding prices of the cost of the Nitrogen per pound, a figure also much discussed, but not explained in Bulletins. The important figures to remember are the price per hundred weight, the price per ton and the equivalent price of the ammonia in the Nitrate per *ton unit. The table is prepared to cover fluctuations in price running from one dollar and eighty cents* per hundred, to *two dollars and seventy cents* per hundred; or from *thirty-six dollars*, to *fifty-four dollars* per ton.

From New Jersey Agricultural Experiment Station.

Bulletin 172.

The Use of Fertilizers. A Review of the Results of Experiments with Nitrate of Soda.

Professor Edward B. Voorhees.

The Use of Fertilizers.

Great gains have been made in the past few years in our knowledge of the necessity of using, and in the methods of use of, commercial fertilizers. A point of primary importance that has been learned is that their application is necessary for the most profitable culture of many of the crops grown, not only in the East and South, but also in sections of the country where it was formerly believed that the natural fertility of the soil would suffice for many generations. Their use has spread from the States of the East and South to those of the Middle and Northwest and Pacific slope—Wisconsin, Colorado, Minnesota and California now use many tons annually. The question as to the need of fertilizer settled, the next in importance is how to use the

materials containing the essential plant-food elements in such a manner as to contribute to the best growth and development of the plants under the wide variety of conditions that exist, and thus secure the largest financial return from their application.

Nitrogen Should Receive Special Attention.

While the three constituents—Nitrogen, phosphoric acid and potash—are all essential, because all are liable to exhaustion, Nitrogen is the one that should receive more careful attention than the others, first, because it is the most expensive of the three to supply. Nitrogen is more expensive than either phosphoric acid or potash, largely because it costs more to produce it. The great natural deposits of phosphates in America and other countries make the possibilities of their exhaustion very remote; besides, the comparative ease of mining, combined with the facilities with which these phosphates may be converted into superphosphates, materially reduces the cost of immediately available phosphoric acid. In the case of potash, the vast deposits of Germany furnish unlimited quantities of crude material, which are readily converted into concentrated salts of potash, free from deleterious substances, and which furnish potash in immediately available forms, and, because of their high content of the essential element, the transportation charges are relatively low per unit of constituent. *Nitrogen, on the other hand, is less abundant, and even though found in the form of Nitrate of Soda as a natural deposit, the quantity is limited in extent, as compared with the deposits of phosphates and potash salts. The location of the deposits in a barren country makes it more expensive, too, to concentrate and to remove impurities, and even when in its most concentrated commercial form, it is comparatively bulky, as compared with the manufactured potash salts, thus increasing the cost of transportation per unit of the constituent.*

Second, because Nitrogen exists in three forms—as organic matter, as ammonia and as Nitrate—and which differ widely in their rate of availability or immediate usefulness to the plant. The Nitrogen in the first and most common form (organic) generally undergoes a change into a Nitrate before plants can make a large use of it; this change requires a longer or shorter time, according to the character of the material. If, therefore, we desire a large and reason-

ably quick use of the constituent when applied in organic materials, it is necessary, first, to select those likely to change rapidly, and second, to depend upon favorable weather conditions—*i.e.*, warm and moist—in order that a rapid change into soluble and available forms can take place, and thus permit the plant to obtain its nitrogenous food—that is, it is possible, in the use of these forms, which must undergo a change, to get very meagre returns, though an amount is applied largely exceeding that necessary for the crop, either because the Nitrogen may have been in such combination as to strongly resist decay, *or the season may have been such as to render the change, in even high-grade materials, so slow as to prevent the plant from obtaining a sufficient amount to meet its demands.* The second, or ammonia, form of Nitrogen is immediately soluble, and is readily distributed in the soil by means of the soil water; it is then fixed until changed into the Nitrate form, *which takes place rapidly under average seasonal conditions*, though an appreciable time must intervene between the date of its application and the time it can be used. *In the case of the third form, the Nitrate, no conditions modify its availability;* it is readily soluble, and immediately distributes itself by means of the soil water everywhere in the soil, and as it comes in contact with the roots of the plants is at once absorbed by them, and continues to be absorbed until used up, or so long as there is sufficient moisture in the soil to cause activity in the plant itself. The availability of the Nitrogen in the various materials may, therefore, range from practically *nil* to 100 per cent., making the matter of selection of material exceedingly important.

In the third place, because Nitrogen, in this immediately available form, is so readily soluble and so completely carried in the soil water, there is danger of its loss by leaching—that is, while there is no question as to the usefulness of this form of Nitrogen—*i.e.*, Nitrate—so far as its absorption by the plant is concerned, the best results are not always obtained from its use, *because advantage is not taken of its peculiar and valuable characteristics;* it is completely soluble in the soil water and distributes itself readily everywhere in the soil, and wherever it comes in contact with the feeding rootlets it is bound to be taken up, hence, when the applications are not properly adjusted, there may be an abnormal and inferior development of plant, because of too large a use of Nitrogen,

or, as it forms no fixed compounds in the soil, there may be a loss from leaching into the drains when applied previous to the growth of the plant or in too large quantities at the wrong time.

In the fourth place, it should receive careful attention, because its right use as a Nitrate—its most available form—permits, not only an economical utilization by the plant, but a control of its growth; it may be used in such a way as to change the natural tendency, and *thus improve it for specific uses;* thus, in addition to the increase in yield *which it may cause, it enhances the market value* of the plant.

Phosphoric Acid and Potash Differ from Nitrogen.

As already pointed out, the mineral elements—potash and phosphoric acid—are relatively cheap as compared with Nitrogen. In the case of potash, the availability of the different forms in which it is usually obtained is not a matter of great importance, since all forms are soluble in water, distribute freely in the soil and are readily absorbed by plants, while in the case of phosphoric acid the soluble and immediately available forms contained in superphosphates may be obtained quite as cheaply as many of the insoluble forms, as animal bone and tankage, which are not so immediately useful; besides, these mineral elements, however soluble when applied, are fixed by the soil, and are thus not liable to rapid loss by leaching. When the farmer applies the "minerals," or materials containing potash or phosphoric acid in their best forms, his initial expenditure is not so great as for an equal amount of Nitrogen; besides, he can depend upon their presence there during the growing season, and also that the plants can make use of the constituents; if the one season's growth of the plant does not use the entire amount supplied, the residues will remain for future crops, though they may be less readily acquired by them. These conditions are quite different from those obtaining when available nitrogenous materials are used, and are the basis of the suggestions frequently made to furnish the soil with an excess of the minerals, but adjust the Nitrogen to the needs of the plant.

A very important thing to remember in the application of Nitrogen, however, is that, though it may appear very efficient, it cannot fulfill all the conditions of a complete fertilizer—it is not a complete food in itself; it is only an

The Best Use of Nitrogen Requires an Abundance of Phosphoric Acid and Potash in the Soil.

element of food, and its value as an element is measured largely by the content of minerals in the soil, with which it must associate and combine, in order to fully meet the food needs of plants. Hence, where Nitrogen in any form is recommended as a fertilizer, it should be understood that the phosphoric acid and potash necessary for the growth of the crop must either be supplied with it, or have been previously applied, or should have existed naturally in the soil. On poor soils, therefore, the application of the minerals must be made with the Nitrogen, while in cases where the soil is naturally rich in minerals, if Nitrogen only is added, the crops are largely increased, because, *by virtue of the presence of Nitrogen, they are able to gather the phosphoric acid and potash needed from the natural supplies in the soil, previously inaccessible to them, because of the deficiency in Nitrogen.* Under such circumstances, it is a commendable practice to use Nitrogen only, as it enables a use of soil constituents, which are of no service while in the soil. The fear that such use of Nitrogen will result in an undue exhaustion of phosphoric acid and potash, which is sometimes expressed, is not well founded, since, *where an increase in crop is caused by the use of Nitrogen only, the amounts of phosphoric acid and potash removed in the crop would not be relatively greater than the amounts removed were some other condition responsible for the increased yield.*

The chances of recovering, in the form of produce, the minerals used in excess are greater than are the chances of recovering all of the Nitrogen used in excess of the needs of the plants, or even that used in moderate amounts, because of the differences in the fixing power of soils for the different elements when in a condition to feed plants. The Nitrogen, when in its available form, the Nitrate, does not form again any fixed compounds with the soil; hence, if the plant does not take it up, it may be lost by virtue of further changes of form, which results in its loss as a gas. *This applies to the Nitrogen in organic and ammonia forms, as well as to the Nitrate.* In the use of Nitrogen, the aim should be to feed the plant; in the case of the minerals, *excessive quantities may be used,* as the accumulations are not liable to escape.

The Best Returns from the Use of Nitrogen Are Obtained When Applied to Good Soils, Well Prepared for Crops.

In the next place, the *best use of Nitrogen is attained when it is applied to soils in good condition, rather than to poor or worn-out soils.* The soils to which high-grade fertilizers are applied should possess good absorptive and retentive properties, in order that the materials applied may be retained for the use of the crop, and the physical character also should be such as to permit a ready *penetration of heat and an easy circulation of water*—conditions which are essential in order that the activities within the soil may be unimpeded, thus making it possible for the plants to easily obtain their needed food. In too many cases good plant-food is wasted because applied to mixtures of sand, clay and other materials, rather than to soils in the true sense, or to soils that have not been thoroughly prepared, the clods and lumps preventing a proper distribution of the material, as well as a ready absorption of moisture and free circulation of the plant-food.

The Kind of Crop an Important Factor in Determining the Agricultural Value of the Nitrogen.

Whether it will pay to use any one or more fertilizer constituents is a question that cannot be answered positively, except by the person who uses them. The relation of the cost of the fertilizer to the value of the increased crop is a variable factor, and, aside from weather conditions, is influenced by the availability of the constituents—that is, the proportion that a crop can obtain of the amount applied, the character and composition of the crop grown, and upon the market value of the crop. Because of the facts already pointed out in reference to the constituent Nitrogen, viz., its cost, its variability in usefulness, and its liability to escape in the drains or air, it is of more importance than either of the other two in its bearing upon this point.

For example, the liberal application of materials containing Nitrogen to crops which possess a low market value may result in a maximum production—that is, as large an increase in yield as it is possible to obtain—yet, because the Nitrogen is so expensive, the value of the increased yield may not be equal to the cost of the Nitrogen applied. On the other hand, its application to crops of a high commercial value, though not so completely used and not causing so large a propor-

tionate gain in crop, may result in a large profit, because the cost of the Nitrogen, though considerable, is relatively a small item when compared with the increased value of the crop obtained from its use.

It is shown in the experiments conducted with Nitrate of Soda, on different crops, that in the case of grain and forage crops, which utilized the Nitrate quite as completely as the market garden crops, the increased value of crop, due to Nitrate, does not in any case exceed $14.00 per acre, or a money return at the rate of $8.50 per 100 pounds of Nitrate used, while in the case of the market garden crops the value of the increased yield reaches, in the case of one crop, the high figure of over $263 per acre, or at the rate of about $66 per 100 pounds of Nitrate. The Nitrate applied was not better in the one case than in the other, but in the case of the bulky crops the plant required a larger amount of Nitrogen to make a unit of crop than in the case of the market garden group; besides, it is a crop of low market value—dry hay will bring, say, $12 per ton, and a good yield is two tons per acre; the market garden group of crops shows a high market value—succulent vegetables will bring as much per ton and the yield will be five to ten times as great. These relations of cost of material applied to value of crop are exceedingly important, and should be carefully looked into before planning for the purchase of materials.

Certain Crops are Especially Benefited by Nitrate Nitrogen.

In the next place, the form of Nitrogen used is very important. Many crops, as, for example, those grown for early spring forage, or for hay or grain, as rye, wheat, timothy, *orchard* and other grasses, are unable to obtain the Nitrogen from soil sources early enough to permit of a rapid and maximum development; the agencies which promote the activities which cause a change of organic forms of Nitrogen into Nitrates are dormant, hence an application of Nitrogen in a completely soluble and immediately available form supplies the plant with what it needs at the time of its greatest need, and great gains in yield are made. In the culture of early market garden crops, too, or such as are improved in quality, and thus increased in value, by virtue of quickness of growth, the Nitrate is of the greatest service. Such crops as tomatoes, cabbage, turnips, beet and others, in order to be highly profitable, must be grown and

harvested early, as anyone can grow them in their regular season; their growth must be promoted or forced as much as possible in a season when the natural agencies are not active in the change of soil Nitrogen into available forms, and the plants must, therefore, be supplied artificially with the active forms of Nitrogen, if a rapid and continuous growth is to be maintained. *Their edible quality is dependent*, to a marked degree, upon this rapidity of development; hence a supply of plant-food in reasonable excess of ordinary demands is essential, in order that unfavorable conditions of season may, in part at least, be overcome.

Top-Dressings of Nitrate of Soda.

Owing to the fact that Nitrate of Soda is frequently used after the seed has germinated and the crop made a partial growth, this method of use is referred to as "top-dressing"—that is, broadcasting over the entire surface, or, in the case of hoed crops, alongside the row. This form of Nitrogen is peculiarly adapted for this method of application, since it is so completely soluble that but a slight amount of moisture is necessary in order to distribute it throughout the soil, and, because of its ready availability, it is used by the plant as soon as it comes in contact with its roots. It is the only form that possesses both these characteristics, and is, therefore, to be particularly recommended for those crops which need an early and abundant supply of Nitrogen.

Profits From the Use of Fertilizers.

The aim usually in the use of artificial fertilizers is to so supplement soil supplies of plant-food as to obtain a profit, and, as already intimated, the profits for the different crops will, to some extent, be in proportion to their economical use of the constituents applied. Still, one should not be deterred from the use of fertilizing materials, even if the conditions should render the application apparently wasteful, or a small recovery of the constituents applied, provided the increase in yield will more than pay the cost of the application. The farmer should calculate what increase in crop is necessary for him to obtain in order to make the use of fertilizers profitable, and if only this is obtained, he should not condemn their use. Many persons seem to have gotten the impression that there is some mystery connected with fertilizers, and that their use is a gamble at best, and are not satisfied unless the returns from the investment in them are

disproportionately large. We very often hear the statement that, by the use of certain fertilizers, the crop is doubled or tripled, as if this were a remarkable occurrence and partook of the nature of a mystery. Such results are not mysterious —they can be explained; they are in accordance with the principles involved.

In an experiment on celery it was shown that the weight of celery from an application of 400 pounds per acre of Nitrate of Soda was two and one-half times greater than that obtained on the land upon which no Nitrate was used, and that very great profit followed its use. This result, while remarkable in a way, was not mysterious; if all the Nitrogen applied had been used by the crop, there would have been a still greater increase. It simply showed that where no extra Nitrogen had been applied the plant was not able to obtain enough to make the crop what the conditions of the season and soil, in other respects, permitted. *In other words, that the soil did not contain a complete food; the Nitrogen was necessary to supply the deficiency.* Favorable conditions are, however, not uniform, and variations in return from definite applications must be expected.

It is quite possible to have a return of $50 per acre from the use of $5 worth of Nitrate of Soda on crops of high value, as, for example, early tomatoes, beets, cabbage, etc. This is an extraordinary return for the money invested and labor involved; still, if the value of the increased crop from its use was but $10, or even $8, it should be regarded as a profitable investment, since no more land and but little more capital was required in order to obtain the extra $5 or $3 per acre. It is the accumulation of these little extras that oftentimes change an unprofitable into a profitable practice.

PRACTICAL SUGGESTIONS AS A RESULT OF EXPERIMENTS.

I. For Crops of High Commercial Value.

Market Garden Crops.

It is well understood by all market gardeners that, in their business, liberal manuring must be practiced, and that the manures used must contain an abundance of Nitrogen, that may be quickly used by the plant, if rapidity of growth and early

maturity are to be attained. The experiments with Nitrate of Soda were, therefore, planned to show in which directions the benefits from its use were observed—whether, for example, in the larger yield of a crop of the same general character, or whether, together with the larger yield, there was an earlier maturity of those crops in which early maturity is an important factor, or whether the marketable quality was improved, thus returning a larger profit for the same yield, or whether all of these factors were involved, and the results showed that, as a whole, benefits were obtained in all these directions. The more important crops of this class were included in these experiments.

Early Table Beets. In the growing of this crop, whose value may range from $300 to $600 per acre, the amount of plant-food annually applied is usually far in excess of that removed in the crops of any year, in order to guarantee against any shortage of food should unfavorable weather conditions intervene; the crop must be kept growing at all hazards. In good practice an application of from fifteen to twenty tons of manure and about one ton of a high-grade commercial fertilizer are used per acre. The plants are usually grown under glass, and transplanted as soon as the land is fit to work. Hence the questions asked by the experimenter were, first, whether an additional application of Nitrogen in the form of a Nitrate would be a profitable practice in connection with this heavy application of all of the plant-food constituents, and second, how much should be used. The applications, therefore, ranged from 400 to 700 pounds per acre. The results from the experiments of two years were emphatic in showing an increase in yield and a considerable profit each year, and though the profits were not in proportion to the amount of Nitrogen applied, the largest net returns were obtained from the heaviest applications; the average net return per acre from 400 pounds was $24.40, and from 700 pounds, $47.55. The influence of the Nitrate was noticeable mainly upon the earliness of crop. In the first experiment the yield of the first picking was 63 per cent. greater from the Nitrated plots than from the one upon which no additional Nitrate had been added. The extra early yield, for which the highest prices were obtained, was increased from 8.3 per cent. on the plot on which 400 pounds were added to 12.8 per cent. on the plot

which received 700 pounds per acre, an increased yield at a less cost per unit of harvesting—points of great importance.

Method of Using the Nitrate.

The amount used may range from 400 to 800 pounds per acre, depending upon the conditions, always remembering that the richer the soil and the better its condition the larger will be the amount of Nitrate that can be used to advantage. The beets are usually transplanted, and one-half of the amount of Nitrate of Soda used may be applied either before transplanting (as the danger of leaching will not be serious) or immediately after, and in about three weeks the balance may be applied. In applying Nitrate after the plants have made considerable growth of top, care should be taken to distribute it as near as possible between the rows, or, if broadcasted, only when the leaves are perfectly dry, so that all of the salt may reach the soil, and thus not be liable to injure the plants. Where it does not seem practicable to make the application of Nitrate of Soda separately, then the Nitrate, in the quantity desired, may be mixed with the commercial fertilizer and all applied at the same time. This practice saves labor and danger of injuring the foliage, though it may result in a slight loss of the Nitrate, as it should be applied long enough before the plants are set to permit of its thorough distribution in the soil. Still, the danger of loss is not great, unless the season is so extremely wet as to prevent cultivation.

Asparagus.

In the case of asparagus, which is a perennial, the final results of the experiments have not yet been secured, though the experience of practical growers is unanimous in favor of its use. This crop, as is the case with early beets, requires heavy manuring or fertilizing, or both, for the highest profit. The advantage of the extra dressings of Nitrate of Soda over other forms of Nitrogen lies chiefly in the fact that it may be appropriated immediately, either for supplying the needs early in the season or to stimulate the growth of tops after cutting has ceased and the crowns exhausted. Where manure is used alone in liberal amounts, the top-dressing with Nitrate would not be likely to be so useful an adjunct as where commercial fertilizers, containing high percentages of minerals, have been used, as it must be remembered here, as always, that Nitrogen is not a complete food, but an element of food, and

cannot exert its full effect except in the presence of the necessary supply of the mineral elements.

Methods of Using Nitrate. In the early spring, as soon as the land is fit to cultivate, the beds are ploughed or cultivated, throwing the earth away from the crowns, and commercial fertilizers, rich in Nitrogen—5 to 6 per cent.—are applied, over the row, at the rate of 800 to 1,000 pounds per acre. The fact that asparagus is a perennial, and the growth in the spring depends largely upon the food stored up in the roots in the fall, the effect of the spring application is not so noticeable in the early cuttings, but materially benefits the later cutting. Commercial beds are usually cut for about two and one-half months, and this long period of continuous removal of shoots reduces the vitality of the crowns, and because the vigor of growth and size of the tops measures, to a marked degree, the size of the next crop, as soon as cutting is finished from 250 to 400 pounds per acre of Nitrate of Soda should be applied. The roots immediately absorb this available form of Nitrogen, which stimulates and strengthens the plant, and enables it to appropriate the excess of minerals which have been applied, and, as a consequence, a large, vigorous and healthy growth of top is made, which not only results in storing the food in the roots for use the next season, but it enables the plant to resist the ravages of the rust. There is no other form of Nitrogen that can be used or other means by which this object can be so readily accomplished as by a liberal supply of Nitrate of Soda, and the result is, not only a larger yield, but a greater proportion of large shoots, which increases the market value of the crop; the growers who practice this system have no difficulty in contracting their entire crop from year to year at very remunerative prices.

Early Tomatoes. A careful study of the special needs of plants shows that there is no other one crop that responds more favorably to the use of immediately available Nitrogen than early tomatoes. The influence of the use of Nitrate is not only shown in the increase in the yield—in some cases practically doubling it—but in the improved quality of crop, and because of the larger crop an increased maturity is virtually secured. These are all points of extreme practical importance. The results of all the experiments conducted in different parts of the country and in

different seasons show an average gain in yield of about 50 per cent., with an average increased value of crop of about $100 per acre.

Methods of Practice.

In the growth of this crop two methods are used, depending largely upon the character of the soil and its previous treatment in reference to commercial fertilizers or manures. In the first, where the farmyard manure and commercial fertilizers, rich in minerals, have been used on previous crops, then Nitrogen in the form of Nitrate only is used, and the application ranges from 150 to 250 pounds per acre. By this method the yields are not so large, but the crop is usually earlier, and the net profit is quite as great as if larger applications of manure or fertilizer were made at the time of setting the plants. The object is early tomatoes, and, under average conditions of season and markets, any application of fertilizer or any practice which would tend to encourage a later growth or longer season would reduce proportionately the net profits.

In the other method, farmyard manures are usually spread upon the soil in the fall or winter, thoroughly worked into the soil in the spring. A fertilizer containing chiefly phosphoric acid and potash is applied broadcast previous to setting the plants, and at the time of setting an application of 100 to 150 pounds per acre of Nitrate of Soda is applied around the hill or over the row. After two or three weeks, depending upon the season and the relative growth of the plants, another application of Nitrate of Soda at the same rate is applied. This, because it minimizes the interruption in the feeding of the plant by furnishing immediately available Nitrogen, causes not only an increase in the yield and marketable quality of the entire crop, but it materially increases the quantity of early fruit. The results of four years' experiments show that, by this method, the value of the increased yield of what may be regarded as extra early fruit averaged about $45 per acre.

How to Apply Nitrate.

As in other cases, care should be used in the application of Nitrate; it should not come in too close contact with the plants, and, if broadcasted after the plants are set, it should be done when they are dry, so that all of the Nitrate may reach the soil. Where a larger quantity is used, as, for example, 300 pounds or more, it is very desirable that fractional dressings

should be made, though care should be used not to make the second application too late, as it encourages a later growth of plants and retards maturity.

Early Cabbage. The cabbage is a gross feeder, and the crop can utilize large quantities of plant-food to good advantage. The experiments with this crop show that even where the land has been fertilized with what would be regarded as reasonable amounts of fertilizers adapted for the purpose, extra dressings of Nitrate have given very profitable returns. The yield has been increased from 40 to 80 per cent., and the net value of crop from $53 to $80 per acre. The experiments also show that what may be regarded as a large quantity of Nitrate, namely, 400 pounds per acre, is superior to any smaller quantity, and further, that this would better be applied in two rather than in a greater number of fractional dressings, as the later applications have a tendency to disproportionately increase leaf growth and retard heading. The most remarkable effect of the Nitrate is shown in the influence it exerts upon the marketable quality of the crop. In the experiments conducted the addition of Nitrate resulted in more than doubling the value of those heads which were marketable—that is, where no Nitrate was applied, $1 per hundred was received, and where 400 pounds of Nitrate were used the price was $2.50 per hundred. These results suggest a reason for the lack of success of many growers, who depend solely upon applications of mixed fertilizers.

Methods of Application. On soils well adapted for the crop—medium sandy loams—the land should be plowed early and well cultivated. If manures are readily attainable, a dressing of ten tons per acre may be applied and well worked into the soil; previous to setting the plants a fertilizer rich in Nitrogen, one containing 6 to 7 ammonia, 6 to 8 phosphoric acid, and 6 to 8 potash, should be applied, preferably broadcast, at the rate of 800 to 1,000 pounds per acre. At the time of setting, or very shortly after, Nitrate of Soda, at the rate of 200 pounds per acre, should be applied, preferably along the row, and cultivated in; this followed two or three weeks later with a second dressing of 200 pounds. The effect of these applications—that is, the presence of an abundance of available Nitrogen—will be to stimulate and strengthen the plant, so that it will

make use of all of the other food in the soil, and be able to overcome, in a great degree, any unfavorable conditions that may prevail later in the season. The natural tendency of the plant to absorb food is gratified, and a maximum crop is the result.

Early Table Turnips.

This is a crop of very considerable importance in market garden districts, and in certain sections is very profitable. The profit, other things being equal, is measured by the earliness with which the crop may be gotten into the market. Owing to the fact that the crop is planted very early, often before the weather is settled, heavy dressings of soluble Nitrogen at time of planting would be liable to considerable loss from leaching. Hence fractional dressings have proved the most satisfactory. The gains obtained in the experiments from the use of Nitrate have ranged from 30 to over 100 per cent., according to the amount applied and method of application. The increased value of crop, due to the Nitrate, averaged about $30 per acre—a very handsome return from the use of the extra fertilizer.

Methods of Application.

Where soils have been previously liberally fertilized, particularly with the mineral elements, the recommendations for fertilizers, which have in practice proved very satisfactory, are as follows: Prepare the soil early and apply a light dressing of manure, either previous to plowing or after plowing, and harrow in well, and apply a commercial fertilizer rich in minerals, say, with a composition of 2 per cent. Nitrogen, 8 per cent. phosphoric acid and 5 per cent. potash, at the rate of 1,000 pounds per acre. After the plants have germinated and well started apply, broadcast, 150 pounds per acre of Nitrate of Soda, following this in two or three weeks with a second application of 150 pounds. The first dressing will serve to stimulate leaf growth and a deep penetration of root, and the second dressing will encourage a rapid growth of the turnip, so necessary if high quality is to be obtained. Applications made later than one month after the seeding usually encourage too large a leaf growth, thus reducing the yield of early crop. In the experiments three equal dressings of 133 pounds each reduced the yield by over 3,000 pounds per acre below that which was obtained in two equal dressings of the same amount as suggested

herewith. The effect of the third dressing seemed to be to induce growth of top rather than root. The increase in the maturity—that is, the quantity of early crop—will be directly increased, in so far as the Nitrate induces a larger crop, which is one of the first results of its application.

Sweet Corn. Very great progress has been made in the growth of sweet corn for the early market, due both to the development of hardier varieties and to greater care in the selection and use of fertilizing materials. These hardy varieties of sweet corn are now frequently planted as early as March as far north as New Jersey, and, when planted so early, the soil supplies of Nitrogen are yet unfavorable for the change of organic or other forms of Nitrogen into the Nitrate form. Hence Nitrate should constitute a large part of the nitrogenous food of the plant if early maturity is to be accomplished. Owing to this fact, the utilization of the Nitrate by the plant is liable to be less than if applied later, as the season for heavy rains, which are liable to carry away part of the soluble Nitrogen, is not yet over, besides, the weather is not warm enough to cause a rapid growth. Practice, however, has shown that, by small fractional dressings of Nitrate early, maximum results may be obtained. In the preparation of the soil for the growth of this crop, therefore, considerable organic nitrogenous material may be used to advantage.

Methods of Practice. A good practice is to manure the soil, either during the fall or winter, with from ten to twelve tons per acre, and apply previous to planting or setting the plants (in many cases the plants are started in the plant-house), a fertilizer rich in phosphoric acid and potash, also containing organic forms of Nitrogen. At time of planting use a compost in the hill, and use the Nitrate as a side dressing after the corn is well rooted. The advantage of the compost and organic forms of Nitrogen is that they supply the soil with an abundance of readily-fermentable material, which, to some extent, warms the soil, besides containing substances useful in later stages of growth. Nitrate may be applied in three dressings, at the rate of 100 pounds per acre in each dressing, and the dressings should be so distributed as to cover the season of growth—that is, as soon as plants begin to form ears the last application of Nitrogen may be made, which encourages a quick growth

of the ears and also makes them much larger. The increased gains per acre when the Nitrate has been used in this way have ranged from $18 to $40—a very profitable use of Nitrogen, as the gain is really in excess of that which would be obtained by average methods of manuring.

Muskmelons.

Soils suitable for the growth of muskmelons are preferably light, sandy loams, not naturally well supplied with any of the constituents of plant growth. The crop does not require large quantities of plant-food, but must have the needed amount in available form early in the season. Experiments that have been conducted through several seasons show that the best form of Nitrogen for this crop is the Nitrate, and that preferably two applications should be made. The increase in yield from the addition of Nitrate of Soda has averaged, practically, 100 per cent., with an average increased value of crop of $100 per acre. It is shown, further, that as in the case of very early crops, that the earliest ripened fruit is not found upon the plants which received the extra fertilizer, but rather upon those insufficiently nourished, and thus forced to maturity because of a lack of food; besides, these specimens are usually small and of poorer quality. The increased value is obtained because of a large crop of finer quality, as a very marked influence of the added nitrogenous substance is noticed in marketable quality of the total crop, reducing very materially the percentage of culls. The experiments showed that, while the percentage of culls, where no Nitrogen was applied, averaged 40 per cent., the average per cent. of culls on the fertilized area was but 25 per cent., indicating that the normal development of fruit requires a sufficient abundance of available Nitrogen.

Methods of Practice.

On light soils, apply broadcast during fall or winter, 8 to 10 tons of manure, which should be plowed in early in spring. After the land is prepared, a high-grade fertilizer should be applied broadcast, at the rate of 600 to 800 pounds per acre, and harrowed in previous to planting. After the plants are well started, apply 100 pounds per acre of Nitrate of Soda; before the vines begin to run, make an additional application of 100 pounds per acre. Care should be taken in the application of the Nitrate, as suggested in the case of the other

crops, not to allow the salt to come in contact with the foliage of the plants.

Cucumbers. In the case of cucumbers, heavier soils may be used, and larger quantities of fertilizers applied. In our experiments, the application of Nitrate in addition to regular methods of fertilization resulted in a very large increase in crop—over 100 per cent.—and an increase in net value of over $60 per acre. The amounts of Nitrate applied may range from 250 to 350 pounds per acre, and it should preferably be distributed more evenly throughout the season than in the case of the melons; 300 pounds per acre, in three applications, gave the best results. The effect of the Nitrate here, as in the case of melons, was particularly noticeable in maintaining a rapid and continuous growth of vine and fruit, thus materially reducing the proportion of culls. For growing this crop to best advantage, the soil should either be well manured or a commercial fertilizer, rich in all of the constituents, should be applied at the rate of 400 to 600 pounds per acre, previous to planting; and after the plants have well started, 100 pounds per acre of Nitrate of Soda should be applied; this to be followed with two further dressings of the same amount. The time between the dressing may range from two to three weeks, according to season.

Celery. Celery is a crop that responds most profitably to an application of an abundance of available Nitrogen. This fertilizer not only increases the yield, but very materially improves the quality of the crop. Where the soil is naturally rich, or where what may be regarded as good methods of practice, in reference to fertilizers, are followed, extra applications of Nitrate result in very largely increased yields and proportionate improvement in quality. In the experiments that were conducted, it was shown that where ordinary treatment was given, and a small and unprofitable crop was obtained, the addition of a few dollars' worth of Nitrate changed the crop into a very profitable one; and in the case of a soil that was regarded as good enough to produce a fair crop, the addition caused a large increase in total crop, and a very marked improvement in the quality. The selling price of roots grown with Nitrate was 150 per cent. greater than where none was applied, and 100 per cent. greater than where an insufficient

amount was used. The increased value per acre of the crop from the best use of the Nitrate was over $250.

Methods of Application.

The celery crop is expensive, both in plants and in labor, and since the cost of these items is the same whether the crop is large or small, intensive systems of feeding the crop usually give excellent returns. The crop is also very much improved in quality if the conditions are made favorable for continuous and rapid growth, hence an abundance of moisture and of immediately available food are prime essentials. The former can be controlled to a large extent by good methods of culture, but the best culture of the best soils is not capable of providing the necessary food, and, of the essential elements of food, Nitrogen seems to be the one that contributes especially to rapidity of growth and to the formation of stalk which possesses that peculiar crispness which in so marked a degree measures marketable quality. Soils that are deep, moist and rich in organic matter are best suited for the crop; these should be heavily manured, say, at the rate of ten to fifteen tons per acre, and should also receive liberal amounts of high-grade commercial fertilizer, at the rate of 600 to 800 pounds per acre, all applied broadcast previous to setting the plants. After the plants are well started, apply 200 pounds per acre of Nitrate of Soda along the row, and, if the weather is dry, cultivate it in, though, ordinarily, the moisture in the soil is sufficient to cause an immediate distribution of the salt; and in three to four weeks make a second application of Nitrate of the same amount and in the same manner. The two applications of Nitrate, of 200 pounds each, will, it is believed, give, on the average, better returns than smaller amounts or a greater number of applications, though the conditions of season may warrant such changes from this method as the judgment of the grower may dictate.

Peppers.

The growing of peppers has become a considerable industry in market garden districts in recent years. Studies of the special needs of the crop show that, on good soils, well adapted for the plant, additional dressings of Nitrate are necessary for best results —the gain in yield averaging 35 per cent., and the increased value of crop due to the added Nitrates averaging $30 per acre. A large quantity—300 pounds per acre—seems to be much superior to any less amount, and, owing to the fact

that peppers continue to form during the entire period of growth, the distribution of the Nitrate throughout the season is desirable where large quantities are applied. Where more convenient the first application of Nitrate may be applied at time of setting the plants, in order to prevent any delay in growth after setting. The later fractional applications are distributed throughout the season, two or three weeks apart.

Early Potatoes. In the growing of early potatoes it is essential that an abundant supply of Nitrogen be at the disposal of the plant. The experience of growers has clearly demonstrated this fact, and, until commercial fertilizers came into general use, most growers used large quantities of yard manure, in order that the plant should suffer no lack of this element. With the introduction of commercial fertilizers, the question of greatest importance has been the source of Nitrogen best suited to meet the demands of the special early growth. The experiments which have been conducted with a view to answering this question have shown clearly that while Nitrate is most useful, a combination of the Nitrate with quickly-available organic forms, as dried blood, or with both organic and ammonia forms, is preferable to the use of any single form.

Methods of Practice. On good potato soils, therefore, a good fertilization should consist of from 800 to 1,000 pounds of a fertilizer containing Nitrogen, 4 per cent.; available phosphoric acid, 8 per cent.; and potash, 10 per cent.; one-third of the Nitrogen at least to be derived from Nitrate of Soda and the remainder from quickly-available organic forms. On soils in good condition the fertilizer may be applied in the row at the time of planting, though many prefer to apply one-half of the desired amount broadcast previously and the remainder in the row with the seed. Where there appears to be a deficiency of Nitrogen, due to the fact that Nitrates have been carried to lower levels by rains, or to the fact that the season has not permitted the change and appropriation of organic forms, then the application of 100 pounds of Nitrate per acre at the time of blossoming will encourage the rapid growth of tubers, though retarding, to some extent, the time of ripening.

Sweet Potatoes. The sweet potato finds its most congenial home in a light, sandy soil, the physical character of the soil measuring, to a large extent, the quality

of the crop, though the method of fertilization will also influence this to a certain extent. This plant seems to have the power of acquiring from the soil Nitrogen that is inaccessible to other plants, and thus, where large applications of this element are made, a tendency to undue vine growth seems to be encouraged, and also to change the marketable quality of the tubers, causing a long, rooty growth, rather than a compact, nodular form. The use of a small amount of Nitrogen is, however, desirable, an increase of from fifty to seventy bushels per acre being secured from such use. Hence, soils rich in Nitrogen, or those upon which Nitrogen has been previously applied in considerable quantities, do not produce tubers of the character demanded by our northern markets—a small, round tuber, which cooks dry and has a nutty flavor. These characteristics of quality cannot be secured in crops grown on heavy soils, nor on sandy soils too liberally supplied with Nitrogen.

Methods of Practice.

The fertilizer may be applied at the time of making up the rows, in order that it may be evenly distributed before the slips are planted. This will encourage immediate growth of plant, and the small quantity of Nitrate which is applied early in the season will not militate against the proper development of the tuber, as an absence of Nitrogen in the soil after the Nitrate has been taken up will discourage the formation of the rooty form of tuber, which is marketable at a lower price.

Experiments have also demonstrated the necessity in the soils of an abundance of minerals, and a fertilizer containing 2.5 per cent. Nitrogen, 7 per cent. available phosphoric acid and 10 per cent. potash, one-half the Nitrogen to be drawn from Nitrate, seems to meet the requirements better than one containing a larger amount of Nitrogen.

II. For Crops of Low Commercial Value.

Hay and Grain.

The growth of hay and the cereals, wheat and rye, forms a very important part of the farming interests of the Eastern, Middle and Southern Coast States. The areas of these crops in eighteen States, includ-

ing Tennessee and Kentucky, are, in round numbers, as follows:

Hay	15,000,000 acres.
Wheat	8,000,000 "
Rye	772,000 "

In most of these States large quantities of commercial fertilizers are used, either because the soils are naturally poor or because they have been depleted of their original constituents by continuous cropping, and, even with added fertilizers, the yields are not large enough to make the crops in themselves highly profitable. In many States the yield in particular districts is large, but the average yield of hay is but 1.25 tons per acre; of wheat, but 13 bushels per acre, and but 15 bushels of rye. The aggregate production of these crops is, however, very large, and, because of the conditions which prevail, it is likely that their growth will continue for some time to come, though it is eminently desirable that the average yield should be increased.

One of the chief reasons for the low average yield is that the farming is on the "extensive," rather than on the "intensive" plan. The relatively large areas used are not well prepared for the seed, and the fertilizers applied do not fully supplement soil supplies of plant-food. These conditions too, are not liable to change at once, because the farmers are not yet prepared to adopt the more rational intensive system; the adjustment to new conditions requires time. The suggestions here given as to the use of top-dressings of nitrogenous substances are therefore of primary importance, because, if followed, it will enable the farmer to obtain more profitable crops, and will encourage the gradual adoption of better systems of practice.

The farmers have, however, reached the point where they are asking the general question: "How shall I profitably increase the yields of these crops?" They are not satisfied with present conditions, nor with the general advice to supply the crops with additional plant-food. The advice is not definite enough, and they are not sure that the cost of expensive plant-food will be returned in the immediate crop, and they cannot afford to wait for future crops to return an interest on the invested capital. As soon as it is made clear that a profitable increase in crop from the use of fertilizers is a reasonable thing to expect, then the questions are—*first,*

"What shall I use?" *second*, "How much shall I use per acre?" and *third*, "When and how shall it be applied?" Experiments that have been conducted with the use of Nitrate of Soda answer all of these questions in a definite and specific way.

Hay.

In the case of hay, from timothy and other grasses, the experiments that have been conducted answer the first question—"What shall I use"—as follows: Use Nitrate of Soda, because it is a food element that is especially needed; it is soluble in water and can be immediately taken up by the plants and supplies them with that which they need at the time they need it—it can be used by them early in the spring before other forms of applied Nitrogen are usable and before other soil supplies are available. The results of experiments conducted through a period of nine years, and in different sections of the State, show that upon soils which will produce crops ranging from one to three tons per acre, a gain in yield of from 9 to 54 per cent., or an average increase of 32.7 per cent., may be expected from the use of from 100 to 150 pounds per acre, which would show an average gain in yield of 654 pounds per acre; based on the average yield of this section of the country of 1.25 tons per acre, the gain would be 820 pounds. This increase, at an average price of $12 per ton, would mean about $5 per acre, or $2 more than the cost of the material. A very satisfactory profit, when it is remembered that it is obtained at the same cost of labor and of capital invested in land.

How Much Shall be Applied.

The second question, as to how much shall be applied, experience teaches that on good soils, in a good state of cultivation, 150 pounds per acre would be regarded as the most useful amount, though on poor soils, 100 pounds would be better, and on richer soils, as high as 200 or 250 pounds per acre may be used with advantage. The reason why a smaller amount is recommended on poor soils is because on such soils there is liable to be a deficiency of the mineral elements, and inasmuch as the Nitrate is not a food complete in itself, but an element of food, the plant would be unable to utilize it to the best advantage in the absence of the necessary minerals. Where the soils are good, or under the intensive plan, larger amounts may be used, as under this system all

the constituents are supplied in reasonable excess, besides every precaution is taken to have the physical condition of the soil so perfect as to provide for the easy distribution and absorption of the food applied. In experiments conducted in Rhode Island the largest profit was obtained from the application of 450 pounds per acre, together with the necessary minerals. This method of practice is one which should be the ultimate aim, and can be accomplished by gradually increasing the amounts as the profits from the crops grown from the application of smaller amounts warrant.

Methods of Application. The experiments, the results of which are confirmed by experience, also answer the third question, as to when it shall be applied. Apply as a top-dressing in spring, after the grass has well started, when the foliage is dry, and preferably just before or just after a rain. If applied earlier than this there will be a slight danger of loss, because the roots will not be ready to appropriate it, and, as it is entirely soluble, it may be washed into the drains. If applied when vegetative functions are active, it is immediately absorbed, and not only strengthens the plant but causes it to throw its roots deeply into the soil and to absorb more readily the mineral food, and thus utilize to a fuller degree the amount of Nitrate applied. It has been shown that, even under the best seasonal and soil conditions, a part of the Nitrate will disappear in any case, and that only *about 75 per cent.* can be expected to be returned in the increased crop, and if this 75 per cent. is all returned in the crop, a maximum of about 1,500 pounds would be produced if the yield only was increased. Frequently, however, not only is the yield increased, but the quality of the hay is improved—that is, there is proportionately more nitrogenous substance in the hay than in that obtained where no Nitrogen has been used, so that, unless the Nitrate has been absorbed uniformly, we cannot expect the yield that may be calculated from the amount of Nitrogen applied. These experiments suggest, further, that, owing to the difficulty of evenly distributing a small amount of Nitrate of Soda, and owing, also, to the fact that, on soils that have been seeded with grass, there is frequently a deficiency of mineral elements, a mixture may preferably be used which is rich in Nitrate, usually one-half, the balance consisting of acid phosphate, ground bone and

muriate of potash. The soluble minerals are readily carried to the roots of the plants, and the ground bone feeds the surface roots, and the Nitrate is absorbed quite as readily as if not used with any other material. This method is to be recommended whenever the land is in good condition, and it is desired to keep up the content of the mineral constituents in the soil, as well as to avoid any danger of overfeeding with Nitrogen, which would have a tendency, particularly in the warmer climates, of causing a softer growth and formation of mildew. This is liable to occur where the Nitrogen is in excess and the ration is not well balanced. A good mixture for top-dressing may be made up as follows:

Nitrate of Soda......	500 lbs.
Ground bone.........	200 "
Acid phosphate.......	200 "
Muriate of potash........	100 "
	1,000 lbs.

Applied at the rate of 200 to 300 pounds per acre.

Wheat.

The answer to the questions as applied to wheat are, in essence, the same, though modified in particular points, owing to the fact that the wheat is grown for grain, rather than for weight of total produce, as in the case of hay, and also because wheat, being seeded in the fall, has not so large a root system as the grass, and therefore greater care should be used in the application of the material. Nitrate of Soda is, however, the substance that is likely to give the most satisfactory results as a top-dressing, because, as already pointed out, it is soluble, and can thus reach every point of the soil without the necessity of cultivation and it is immediately available, and thus supplies food at once or at the time most needed, energizing the plants weakened by the winter and strengthening those already vigorous and enabling them to secure a larger proportion of the mineral elements. The time of application should be early in spring, or after growth has started.

Gains from the Use of Nitrate of Soda.

The results of experiments conducted to answer this question show a gain in both grain and straw from the top-dressing of Nitrate of Soda. The yields per acre, without the top-dressing, ranged from eleven to twenty-seven bushels of grain per acre and from 1,500 to 1,800 pounds of

straw, thus showing a wide variation in the character of the soils used and in seasons, making the average of the results generally applicable.

The gain in yield of grain ranged from 25.9 to 100 per cent., while that of straw ranged from 54 to 100 per cent., or an average of 60.8 per cent. increase in the case of the grain, and 83.8 per cent. increase in the case of the straw. The value of these increased yields, at average prices, shows a large profit in all cases. Applying this to the average yield per acre of wheat and straw, namely, thirteen bushels of wheat and 1,600 pounds of straw for the Eastern and Southern States included in our discussion, we find a gain of 7.9 bushels of wheat and 1,340 pounds of straw, and a valuation of seventy-five cents per bushel for wheat and $6 per ton for straw, which prices probably represent the average, though not as high as are now prevailing, the total value of the increase is $9.95, or a net gain of $6.20 per acre, using the high price of $50 per ton for the Nitrate of Soda. The profit here indicated is a good one and should make wheat raising more encouraging, besides stimulating the farmer to better practice in other directions. The calculated yields from the use of Nitrate are not unreasonable to expect, since on good wheat soils and with fairly good management, without the additional Nitrate, the average yield is over twenty bushels per acre.

The Amount to Apply.

In reference to the second question, as to how much Nitrate shall be applied, the experiments show that on soils in a good state of cultivation, those that will produce from, say, fifteen bushels per acre, without top-dressing, 150 pounds per acre, the average amount used in the experiments, would be the most useful; though, on poorer soils, which would average ten to twelve bushels per acre, 100 pounds would be better, for the reasons already discussed in the case of hay.

On better soils, where quantities larger than 150 pounds per acre seem desirable, it is strongly recommended that two applications of equal weight be made; the first, when the plants have well started, and the second, when the crop is coming in head. Very often the season is such as to encourage a rapid change of the insoluble Nitrogen in the soil, in which case too large an application in the spring would tend toward an undue development of leaf and the ripening would

be impaired, hence the advantage of dividing the amount is apparent, as, if the season is good and the growth normal, the second application may be dispensed with. Where the soil is liable to be deficient in minerals, and this is often the case, the Nitrate may be mixed with other materials, as recommended for hay, the excess of minerals not used for the wheat providing for the following crop.

Rye.

The three experiments with rye in 1894 confirm the conclusions reached in both the experiment on hay and wheat, that Nitrate of Soda as a top-dressing proves desirable in effectually increasing the yield of both grain and straw, and which is accomplished at a profit. The average yield of crops without top-dressing ranged from 9.3 to 15.4 bushels of grain, and the increase from the application of 100 pounds of Nitrate of Soda ranged from 21 to 37 per cent. for grain, and from 33.5 to 37 for straw, or an average increase of 28.5 per cent. for grain and 35.7 for straw. The yield obtained without top-dressing is not so large as in the case of the wheat, nor is the increase proportionately as large, due undoubtedly to the fact that the rye is usually grown on poorer land than wheat, and that only 100 pounds are used, though this small amount is recommended because of the relatively lower price of grain. Applying this percentage increase, however, to the average yields, as shown by the States mentioned, namely, fifteen bushels of rye, and 1,800 pounds of straw per acre, we have a gain of 4.28 bushels of grain and 603 pounds of straw. At sixty cents per bushel for the grain, and $12 per ton for the straw, the gain is $6.18, or a net profit from the use of Nitrate of Soda of $3.93 per acre, a very handsome return for the investment. The suggestions as to the amount and time to apply are practically the same as for the wheat and hay, though, owing to the fact that the straw is relatively more valuable than the grain, the larger applications may be made for the rye than for wheat, as an abnormal increase in the proportion of straw would not result in lowering the total value of the crop.

Experiments with Forage Crops.

At this Station during the years 1899 to 1902 seven experiments were conducted with Nitrate as a top-dressing on forage crops, the Nitrate being used in addition to the manures and fertilizers generally used, and the follow-

ing tabulations show the yield and gain per acre obtained. It will be observed that in all cases a very marked increase due to the application of Nitrate occurred, ranging from 34.1 per cent. for corn to 96.6 per cent. for barley—a profitable return from the use of the Nitrate on all crops except the barley, which, owing to unfavorable weather conditions, did not make a large yield. Applying this percentage increase to what has been shown to be average yields of these crops without Nitrate, we have the following table, which shows the gain per acre and the value of the increase on all crops at an assumed value of $3 per ton:

Yield of Forage Crops Per Acre.

	Number of Experiments.	Fertilizer.		Increased Yield.	Percentage, Gain.	Average Yield.	Increased Yield.	Value of Increased Yield at $3 per Ton.
		Nothing.	Nitrate of Soda.					
		lbs.	lbs.	lbs.		lbs.	lbs.	
Rye............	1	9,520	13,100	3,580	37.6	10,000	3,760	$5.64
Wheat...........	1	9,280	15,000	5,720	61.6	10,000	6,160	9.24
Barnyard Millet..	2	14,355	21,540	7,185	50.0	14,000	7,000	10.50
Corn............	1	20,400	26,800	6,400	31.4	20,000	6,280	9.42
Oats and Peas....	1	6,250	9,530	3,280	52.5	10,000	5,250	7.88
Barley...........	1	2,400	4,720	2,320	96.6	8,000	7,728	11.59

It will be observed that the value of the increased crop ranges from $5.64 to $11.59 per acre—a profitable increase in every case, as the average cost of the Nitrate did not exceed $3.60. This profit does not take into consideration the fact that the average increase for all the crops was over 50 per cent., thus reducing, in this proportion, the area required for the production of a definite amount of food—a point of vital importance in the matter of growing forage for soiling purposes. In other words, it is shown that, not only is there a profitable gain, but that with these crops the application of Nitrate of Soda made it possible to double the number of cattle or the number of cows that could be kept on a definite area.

In the case of the wheat and rye the application was made when the plants were well started in the spring. In

the case of the spring or summer-seeded crops the applications were made after the plants were well started and root systems well established and ready for the rapid absorption of food. In raising forage crops the best results, in fact, satisfactory results, can only be obtained when grown under the intensive system. The soil must be well prepared and an abundance of all the elements of plant-food supplied. Hence, the application of Nitrate may be greater than is usually recommended for grain crops under the extensive system.

Methods of Application.

Although there are many valuable suggestions offered by the experiments, at least two are of fundamental importance, and cannot be too strongly urged upon the attention of farmers:

1. That the constituents Nitrogen, phosphoric acid and potash, as found in commercial supplies furnishing these elements, do serve as plant-food, nourishing the plant in the same manner as those in home manures, and should, therefore, be liberally used, in order to guarantee maximum crops.

2. Of these constituent elements Nitrogen is of especial importance, because it is the one element which, in its natural state, must be changed in form before it can be used by the plants. *Hence, its application in an immediately-available form is especially advantageous for quick-growing vegetable crops, whose marketable quality is measured by rapid and continuous growth, and for those field crops which make their greatest development in spring, before the conditions are favorable for the change of the Nitrogen in the soil into forms usable by plants.*

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Editor: W. H. BEAL.

Prepared in the Office of Experiment Stations.
A. C. TRUE, Director.

Page 7.

"*Under existing conditions farmers are advised to purchase fertilizer materials and to make their own mixtures rather than to purchase mixed or complete special fertilizers. This course is believed to be advisable for two reasons: First,*

*because the 'specials' are not properly compounded, and second, because the needed plant food can be thus procured at lower cost."**

The continuous use of muriate of potash may so far deplete the soil of lime that an occasional application of this material may be required in case of such use. *The sulphate of potash may be a safer material to use where a growth of clover is desired than the muriate,* and therefore it may often be wise to use the sulphate. The high-grade sulphate should be selected.

These materials should as a rule be mixed just before use, and applied broadcast (after plowing) and harrowed in just before planting the seed. *Where Nitrate of Soda is to be used in quantities in excess of 150 pounds per acre, one-half the amount of this salt may be withheld until the crop is 3 or 4 inches high, when it may be evenly scattered near the plants.* It is unnecessary to cover this, though it may prove more promptly effective in absence of rain if cultivated in.

The quantities recommended are in most cases moderate. *On soils of good physical character it will often prove profitable to use about one and one-half times the amounts given.*

SUMMARY OF INCREASED YIELDS.

From Application of 100 Pounds per Acre of Nitrate of Soda.

Rise in Price of Farm Products.

It should be pointed out that in the recorded experiments with Nitrate of Soda on Money Crops heretofore published in Experiment Station Reports and Bulletins, farm products were much lower in price. The prices of agricultural products have risen to a high water mark, and in certain cases the advance has been to extreme figures, and all farm commodities are now higher than they have been for some years. Our statements heretofore published, showing the

Margin of Profit Greater.

profit resulting from the crop increases due to the use of Nitrate of Soda, if rearranged on a basis of present values for crops, would show more profit than before. It should also

* U. S. Department Agricultural, Farmers' Bulletin, 65 and 84 (Experiment Station Work, II, page 27; VII, page 5).

be remarked that the prices of other Ammoniates have risen higher than Nitrate of Soda, and it is as heretofore the cheapest of all Ammoniates in the market.

Other Ammoniates Higher.

Economists of authority tell us that the cost of living is to remain for a considerable time on the high basis now established, so that it is to be expected that the prices of agricultural products will remain at a high level.

Probable Stability of Farm Values.

In this connection your attention is called to many experiments with Fertilizers in which Nitrate of Soda is said to have been used in order to produce results to be exploited as due to materials other than this Standard Money Crop Producer.

Good Results Due to Nitrate.

Further, one may add, that when Nitrate is used at the rate of 100 pounds per acre, the actual cash increase in Fertilizer cost per acre is very small, and when used in mixed goods it cheapens the cost per ton of the Fertilizer.

Result Slight Added Cost per Acre and per Ton of Fertilizer.

The highest agricultural authorities have established by careful experimentation that 100 pounds of Nitrate of Soda applied to the crops quoted below has produced *increased* yields as tabulated hereunder:

What Nitrate Has Done for Crops.

Barley	400 pounds of grain.
Corn	280 pounds of grain.
Oats	400 pounds of grain.
Rye	300 pounds of grain.
Wheat	300 pounds of grain.
Potatoes	3,600 pounds of tubers.
Hay	1,000 pounds, barn-cured.
Cotton	500 pounds seed-cotton.
Sugar Beets	4,000 pounds of tubers.
Beets	4,000 pounds of tubers.
Sweet Potatoes	3,900 pounds of tubers.
Cabbages	6,100 pounds.
Carrots	7,800 pounds.
Onions	1,800 pounds.
Turnips	37 per cent.
Strawberries	200 quarts.
Asparagus	100 bunches.
Tomatoes	100 baskets.
Celery	30 per cent.

It should be remembered that plants take up most of their Nitrogen during the early period of their growth.

It is now known that there is not as much danger of it being leached out of the soil by the rains during the growing season as has been generally believed, since the rains seldom reach lower than the bottom of the furrow, and the movement of the soil moisture is up instead of down. Besides, soil moisture is strongly held by good soils by capillary attraction.

Nitrate of Soda looks somewhat like common dairy salt, and horses, cows and sheep, if they can get to it, may eat it to an injurious extent.

The emptied bags, especially in damp weather, have more or less Nitrate adhering to them. After emptying, it is a good plan to soak in water, which will make an excellent liquid manure, say one empty bag to a barrel of water.

If lumpy, the Nitrate should be broken up fine, which is easily done by pounding it on the barn floor with the back of a spade or shovel, or by a hand grinding machine made especially for home mixing, which is now in common use in Europe and beginning to be used in America.

If the Nitrate is to be mixed with superphosphate or other fertilizers, put the desired quantity of each in a heap on the floor and turn it over until it is uniformly mixed.

Nitrate of Soda, unlike sulphate of ammonia, dried blood and other complete mixed fertilizers, can be mixed with lime or ashes without loss of Nitrogen.

FROM BULLETIN No. 67.

Maryland Experiment Station on the Culture and Handling of Tobacco in Maryland.

H. J. PATTERSON, Director and Chemist.

From Page 140.

Tobacco.

The following materials are well adapted for use in making fertilizers for tobacco:

Dissolved South Carolina rock, dissolved bone, dried fish, bone-tankage, cotton-seed meal, Nitrate of Soda, sulphate of ammonia, high grade sulphate of potash, carbonate of potash and magnesia, and cotton-seed-hull ashes.

As a rule, in mixing fertilizers there is not as much Nitrogen and potash used as would be beneficial and profitable. By the use of crimson clover and cow-peas for adding humus to the soils the amount of Nitrogen or ammonia furnished by commercial fertilizer could be either kept low or reduced. *Farmers should generally aim to mix their own fertilizers, as by this means they are sure of what goes into the fertilizer, and, as a rule, they get the plant food cheaper than by purchasing it in ready mixed goods. The mixing of fertilizer can be easily and cheaply done on the barn floor, by the aid of a hoe, shovel and coarse sand screen.*

Home Mixing.

The following figures give the approximate percentage which each 100 pounds of the various ingredients will represent when they are added to a mixture and the whole made up to a ton or 2,000 pounds.

Each 100 pounds of dissolved South Carolina rock represents 7-10 per cent. of phosphoric acid in a ton mixture.

Each 100 pounds of standard dried fish or tankage will represent ½ per cent. of ammonia and 4-10 per cent. of total phosphoric acid in a ton mixture.

Each 100 pounds of *Nitrate of Soda* will represent about one (1) per cent. of ammonia when made up in a ton mixture.

Each 100 pounds of high-grade sulphate of potash will represent about 2½ per cent. of potash when made up into a ton mixture.

For illustration, a fertilizer which has been used with good results on the Station farm for tobacco was made up as follows:

Dissolved South Carolina rock	1,300 lbs.
Tankage (10 per cent.)	400 lbs.
Nitrate of Soda	100 lbs.
High-grade sulphate of potash	200 lbs.
Total,	2,000 lbs.

This contained approximately:

Phosphoric acid (P_2O_5)	9 to 10 per cent.
Potash (K_2O)	5 "
Ammonia	3 "

Terms Used in Discussing Fertilizers.

NITROGEN may exist in three distinct forms, viz., as Nitrates, as Nitrogenous organic matter, as ammonia salts.

NITRATES furnish the most readily available forms of Nitrogen. The most common is Nitrate of Soda.

NITRATION, or nitrification, is the process by which soluble Nitrate is formed from the less available and less soluble Nitrogen of dried blood, cotton-seed meal, tankage and ammonia salts. It is due to the action of microscopic organisms, and all nitrogenous fertilizers must undergo this process of nitration before plants can use them.

PHOSPHORIC ACID, one of the essential fertilizing ingredients, is derived from materials called phosphates. It does not exist alone, but in combination, most commonly as phosphate of lime in the form of bones, Peruvian guano and Rock phosphate. Phosphoric acid occurs in fertilizers in two forms—available and insoluble phosphoric acid.

SUPERPHOSPHATE.—In natural phosphates the phosphoric acid is insoluble in water and not available to plants, except in the form of very fine powder. Superphosphate is prepared from these by grinding and treating with sulphuric acid, which makes the phosphoric acid more available. Superphosphates are sometimes called acid-phosphates. Peruvian guano contains much available phosphate when finely ground.

POTASH, as a constituent of fertilizers, exists in a number of forms, but chiefly as sulphate and muriate. The chief sources of potash are the potash salts, muriate of potash, sulphate of potash. Canada wood ashes and cotton-hull ashes are also sources of potash and also Nitrate of Potash.

Ammoniates.

	Per Cent Ammonia.	Lbs. Ammonia Per Ton.
Nitrate of Soda	19	380
Dried blood	14.5	295
Tankage	13.3	266
Dry fish scrap	10	200
Cotton-seed meal	8.5	170
Barnyard manure	0.6	12

Phosphates.

	Per Cent Phosphoric Acid.	Lbs. Phosphoric Acid Per Ton.
Superphosphate	14	280
Ground bone	22	440
Bone tankage	12	240
Thomas slag	16	320
Barnyard manure	0.32	6.40

Potashes.

	Per Cent Actual Potash.	Lbs. Potash Per Ton.
Nitrate of Soda	1 to 3	20 to 60
Muriate of potash	50	1,000
Sulphate of potash	52	1,040
Canada wood ashes	6	120
Cotton-seed hull ashes	25	400
Waste from gunpowder works	18	360
Corn cob ashes	23	460
Maryland marls	1.25	25
Peruvian guano	2.61	52.2
Castor pumace	1.5	30
Tobacco stems	6.5	130
Barnyard manure	0.43	8.6

Sodas.

	Per Cent Actual Soda.	Lbs. Soda Per Ton.
Carbonate of Soda	50	1,000
Sulphate of Soda	43	860
Nitrate of Soda	35	700

SOUTH CAROLINA AGRICULTURAL EXPERIMENT STATION.

From Bulletin No. 56.

Wheat.

I. Comparison of Varieties.
II. Quantity of Seed per Acre.
III. Experiment with Nitrogen.
IV. Home Manures.
V. Commercial Fertilizers.
VI. Tillage.

Page 5.

Fertilizers.

If wheat is sown upon land deficient in organic matter, it is wise to use a complete fertilizer, containing Nitrogen, phosphoric acid and potash.

If wheat shows an unhealthy appearance in early spring, especially upon sandy lands, an application of seventy-five pounds of Nitrate of Soda *will prove beneficial provided there is enough phosphoric acid in the soil to co-operate with it to make the grain.*

Experiment with Nitrogen.

Object. To compare effects of Nitrogen from cotton-seed meal and Nitrate of Soda and the latter applied with the seed and as a top-dressing.

The intention was to use on each plot a constant quantity of phosphoric acid and potash as the equivalent of these ingredients in 200 pounds of cotton-seed meal.

The first plot received cotton-seed meal alone, yield	17.5 bus.
The second, phosphoric acid and potash and Nitrate of Soda all applied with the seed, yield	20.8 bus.
The third received only phosphoric acid and potash, yield	17.6 bus.
The fourth received in addition to phosphoric acid and potash applied with the seed, Nitrate of Soda as a top-dress, yield	19.4 bus.

UNIVERSITY OF ARIZONA AGRICULTURAL EXPERIMENT STATION.

Timely Hints for Farmers, No. 31.

PROF. W. W. SKINNER.

A fertilizer of about the composition given below has frequently been advised by the Station for *fertilizing orange orchards*, and is believed to be in every way suited to the purpose. It should be applied at the rate of from 500 to 1,500 pounds to the acre, according to age of trees and

quality of soil, and "plowed in deeply at the edge of the branches, about the beginning of the growing season."

Formula:	Pounds.
Bone tankage (10 per cent. ammonia)	1,000
Nitrate of Soda	140
Sulphate of potash	60
Dissolved bone (16 per cent. available phosphoric acid)	800
	2,000

PURDUE UNIVERSITY, INDIANA AGRICULTURAL EXPERIMENT STATION,

LAFAYETTE, IND.

C. S. PLUMB, Director.

Bulletin No. 84.

Growing Lettuce With Chemical Fertilizers.

BY PROF. WILLIAM STUART.

The subject of lettuce culture with chemical fertilizers was undertaken by the writer some years ago, and has been continued.

Page 134.

Availability of Nitrogen.

It is safe to infer that *for any quick growing crops, or where an application of Nitrogen is desirable in the maturing of a crop, the Nitrate of Soda is preferable to dried blood.*

Conclusions Pertaining to Nitrate of Soda.

The results obtained from the several experiments enumerated seem to invite the following conclusions:

1. That in order to study the action of the three essential elements of plant food, Nitrogen, phosphorus and potassium, a soil must be used that is fairly deficient in plant food.

2. That potash when used in any considerable amount, either alone or in connection with Nitrate of Soda, produced conditions unsuitable to plant growth.

3. When phosphoric acid was used alone or in connection with Nitrate of Soda or muriate of potash, even in

large amounts, a marked increase in the growth of the plants was obtained.

4. The muriate of potash proved somewhat superior to the sulphate, the increase in each case being but slight.

5. But little difference seems to obtain in the efficiency of different forms of available phosphoric acid.

6. In each instance chemical fertilizers proved slightly superior to stable manures.

7. The application of liquid fertilizers from below by the sub-watering method proved perfectly feasible and gave satisfactory results.

8. *Nitrate of Soda gave quicker returns than did dried blood, and seems best adapted to lettuce culture.*

9. The sub-watered plants made a better growth than the surface watered ones.

MASSACHUSETTS EXPERIMENT STATION.

Fertilizers for Garden Crops.

Since 1892 the Massachusetts Hatch Station has been conducting series of experiments to test the relative *value of Nitrate of Soda, sulphate of ammonia, and dried blood,* as sources of Nitrogen for different garden crops; and, at the same time, to make a comparison of muriate with sulphate of potash, when used with each of the three Nitrogenous fertilizers for the same class of crops. Dissolved bone-black was applied equally to all plats from the first. These experiments were continued unvaried until 1897. Sulphate of potash in connection with *Nitrate of Soda generally gave the best crop;* in cases where it did not, it gave one but slightly inferior to the best except in the case of one crop, sweet corn, a plant which makes much of its growth in the latter part of the season. *Nitrate of Soda in almost every instance proved the most valuable source of Nitrogen,* whether used with muriate or sulphate of potash. *Sulphate of ammonia and muriate of potash when used together gave the poorest yield in every instance.*

Up to 1897, as has been already stated, only chemical fertilizers were used, but in 1898 a change was made in the plan of the experiment. In view of the fact that market gardeners, in whose interest chiefly these experiments were

carried out, almost invariably use large quantities of stable manure, and employ commercial fertilizers, if at all, simply to supplement the manure, it was decided to apply equal amounts of thoroughly mixed stable manure to each plat and to use in addition the same fertilizers as before. Further, in order to have the best data for determining whether the fertilizers should prove in any degree useful, another plat was added to which manure alone was applied. A number of different garden crops were grown, including spinach, lettuce, table beets, tomatoes, and cabbage; and, as a second crop, turnips.

Spinach.

Spinach gave by far the best results with Nitrate of Soda. With sulphate of ammonia it was almost an absolute failure, many plants dying soon after germination and most of the others becoming yellow and sickly. Sulphate of potash gave better returns than the muriate. Similar results were obtained with beets. Most of the plants on the sulphate of ammonia plats became weak and sickly and many died. The results with tomatoes were also in part similar. Sulphate of potash gave better returns than the muriate, and *Nitrate of Soda gave the best yield of any of the sources of Nitrogen.* This is thought to be due to the fact that the tomato is not set until about the first of June, and makes most of its growth when the season is well advanced. By this time the injurious compounds formed by the sulphate of ammonia have been washed away by rain or destroyed by further chemical changes. The crops that were injured by the sulphate of ammonia—spinach and beets—are sown early and make most of their growth before the season is far advanced.

Lettuce yielded better on barnyard manure alone than on the plats to which fertilizers were also applied. The result is in line with results obtained at the New York State Station, where it was found that "after the soil has received a heavy application of stable manure, any further addition of chemical fertilizers is only thrown away." *Here, as before, sulphate of ammonia was found to be highly injurious.*

Cabbage appeared to be somewhat benefited by the addition of fertilizers to barnyard manure. The difference in the effect of the different fertilizers was not very marked. *Nitrate of Soda appeared to be the best source of Nitrogen.*

The plats from which the beets, lettuce and spinach had been harvested were plowed and sowed to turnips without further fertilizing. In this case the crop was decidedly better on the plats which had received fertilizers in addition to manure.

MARYLAND AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 91.
Page 44. Table 7.

Nitrate of Soda vs. No Nitrate of Soda Applied on Wheat; Wheat Unfertilized in Fall.

Plot No.	Yield of Grain per Acre, Bushels.
1. Neither fertilizer nor Nitrate of Soda	10.4
2. Nitrate of Soda, with no Other Fertilizer	18.1*

Comparison of Nitrate of Soda and Sulphate of Ammonia Both With and Without Lime.

As has already been explained, the Nitrate of Soda and Sulphate of Ammonia represent the mineral sources of Nitrogen commonly found on the market. The Nitrate of Soda is readily soluble in water and is directly available to plants; *while the Sulphate of Ammonia, though quite soluble, has to be changed into a nitrate before it can be used by crops.* Hence the action of these two materials is not the same on different soils and under varying weather conditions. The Sulphate has been preferred by some because it would act slower and was not so liable to leach from the soil; yet if conditions for nitration were unfavorable, it might not be available to the crop when needed. Again, under some circumstances, Sulphate of Ammonia has been found to be actually harmful to plants. The use of Lime in connection with the Sulphate of Ammonia has been found by Professor Wheeler, of Rhode Island, to be valuable, in many cases, as a correction of its harmful effects and to be necessary for its nitrification. Professor Wheeler has made a very exhaustive study of the use of Lime with these mineral sources of Nitrogen; they agree, in the main, with the results obtained at this Station.

*Gain of 7.8 bushels, or seventy-five per cent.

Some Practical Hints Regarding Nitrate.

It is the quickest acting plant food known.

It is immediately available for the use of plants as soon as it goes into solution.

It does most of its work in one season. More must not be expected of it, as it gives quick returns and large profits when properly applied. It tends to sweeten sour land.

When applied broadcast it should be evenly distributed. In applying 100 pounds to an acre, one pound has to be evenly spread over 48 square yards, and this requires care and skill.

It is well to mix it with sand, marl, ashes, land plaster or some other finely divided material of about the same weight in order to secure a more even distribution.

Where plants are grown in hills or drills it should be applied near the growing plants and *thoroughly* mixed with the soil.

It does not matter whether it is sown in dry or wet weather except that when applied broadcast to crops like cabbage, which have a large leaf surface, it should be done when the leaves are not wet from rain or dew.

It does not blow away, and dews are almost sufficient to dissolve it. It is not necessary to wait for rain.

It should be sown early in the spring for cereals, just as they are starting to make their first growth; for roots, after they are transplanted or set out.

Autumn sowing is generally not advisable except as an extra top-dressing for Danish or winter cabbage just as they are starting to head, which is practiced very profitably by large cabbage growers.

It enables the plant to make use of the necessary mineral elements in the soil to the best advantage.

There are no *unknown* conditions that enter in, in reference to the solubility, and hence the availability of Nitrate of Soda.

The Use of Nitrogenous Fertilizers on Vegetables.

Kale.

An application of 50 pounds of Nitrate of Soda and 100 pounds of Dried Fish per acre, in May, increased the growth 30 per cent.

Lettuce.

An application in March at the rate of 250 pounds of Nitrate of Soda and 750 pounds of Dried Fish per acre, to Lettuce, in cold frames, made the crop ready to market one week sooner and increased the yield five pounds per sash or 12,000 pounds per acre; which at two cents per head would have a value of $240 per acre.

Potatoes.

Several experiments have been tried on the use of Nitrate of Soda as a top-dressing for early potatoes. This was applied at the rate of 100 pounds per acre, after the potatoes were up and started to growing. One year this treatment increased the yield of merchantable potatoes 100 bushels per acre, and the average of several years was 20 per cent. increase.

Tomatoes.

Some of the early work of this Station was with fertilizers for tomatoes. The results in detail are given in Bulletin No. 91, but it showed that Nitrate of Soda was particularly active with this crop and produced a larger increase than any other single ingredient. An application of 160 pounds per acre caused an increase of as much as five tons of tomatoes.

There has been much valuable work conducted upon the use of Nitrogenous Fertilizers with various crops, and particularly vegetables. This work has proven that this plant food is a potent factor in increasing the yields and improving the quality.

Cantaloupes.

With regard to the matter of fertilizing cantaloupes, continuous and rapid growth is essential to earliness and a good crop, and Nitrate of Soda under the proper conditions and with proper care, will yield such results. A dressing of Nitrate of Soda alongside the rows in cultivating, in addition to the general fertilizer used, has been most successful. A general fertilizer may be made up as follows:

Dried Blood or Cotton-Seed Meal	400 lbs.
Superphosphate (14 per cent.) or Peruvian guano	600 lbs.
Sulphate of potash	200 lbs.

General Points as to Method of Application.

The points to be observed in the use of Nitrate of Soda are: Avoid an excess, and avoid wetting the foliage with solutions of it, and do not sprinkle the wet foliage with dry Nitrate, and in general Nitrate must not be allowed to come in contact with the stems or leaves of plants. Nitrate of Soda is a nitrated ammoniate, and is immediately available as plant food. The general fertilizer above suggested may be applied at the rate of 1,200 pounds to the acre, and subsequent applications of Nitrate of Soda may be made at the rate of 100 pounds to the acre, say about two weeks apart, during the growing season, and best by placing the Nitrate well mixed with land plaster or fine dry soil before applying, say one-quarter of an ounce to one-half of an ounce to each hill. There is no Nitrogenous Fertilizer in the market at the present time which sells as low as thirteen cents a pound for the Nitrogen contained in it, which is what Nitrate Nitrogen would cost at the price of $2.00 per cwt. In looking at quotations Nitrogen in Sulphate of Ammonia costs fifteen or sixteen cents wholesale; and Dried Blood, Tankages and Mixed Fertilizers anywhere from sixteen to twenty cents. Nitrate is, therefore, the cheapest Ammoniate in the market even at its present quoted price of two dollars and twenty-five cents a hundred. The latter price is wholesale and applies only to lots of five tons or more. The prices for all Nitrogenous Fertilizers are likewise wholesale for five to fifteen-ton lots, and smaller amounts cost more. It should be borne in mind that prices for all agricultural crops have risen proportionately much higher than Nitrogenous Fertilizers, and especially so as to Nitrate of Soda.

Nitrate for Experiments.

As Nitrate is a Powerful Plant Tonic and Energizer *it is NOT a stimulant in any sense of the word;* a very small quantity does a very large amount of work. Broadcast the Nitrate as soon as the frost leaves the ground in the spring.

I never recommend the use of Nitrate of Soda alone, except at the rate of not more than one hundred (100) pounds to the acre, when it may be used *without* other fertilizers. The phosphatic and potassic manures should usually be applied in connection with Nitrate of Soda at the rate of about two hundred and fifty (250) pounds to the acre of each, or if used on the plots (20 ft. by 20 ft.) not more than three pounds of each should be applied thereto. One hundred pounds per acre you will generally find profitable for all crops. It will be found quite satisfactory also in its after effect and in perceptibly sweetening sour land.

Grass.

According to Dr. Wheeler's experiments in Rhode Island soils are less exhausted when complete fertilizers are used with Nitrate than when no Nitrate is used. The Soda always left behind after the Nitrate of Soda is used up conserves always the Lime and Potash, and unlocks the soil Silicates and thereby frees Lime and Magnesia. The Feeding value of Hay is far greater when Nitrate is used as a fertilizer in this connection.

Rhode Island Formula:

Nitrate of Soda	300 lbs.
Sulphate of potash	200 lbs.
Acid phosphate or its equivalent in Thomas slag	400 lbs.

Manures.

Dr. Voelcker, F.R.S., made analyses of fresh and rotted farmyard manures. These analyses show a larger percentage of soluble organic matter in rotted than in fresh manure. The fresh manure contains more carbon and more water, while in the rotted manure the Nitrogen is in more available form for root-absorption.

If the process of fermentation has been well managed, both fresh and rotted manures contain the same amounts of Nitrogen, phosphoric acid, and potash.

Litter.

There should be a sufficient amount of litter to absorb and retain the urine and also the ammonia formed in the decomposition of the manure. Leaves, straw, sawdust, moss, etc., to which is added some peat, muck, or fine, dry, loamy earth, mixed with gypsum

(land plaster), may be used for litter. The relative value of the manure is diminished by the use of too much litter, but on the contrary, if insufficient absorbent material is used, too much moisture prevents fermentation and the consequent chemical changes in the nitrogenous constituents of the manure.

Management of Farm-Yard Manure.

The best method for the management of farmyard manure is to make and keep it under cover, in sheds, or better still, in covered pits from which there can be no loss by drainage. It should also be kept sufficiently moist, and by the addition of charcoal, peat, or vegetable refuse and *gypsum* the volatilization of ammonia may be reduced to a minimum. Manure so made is worth 50 per cent. more than that thrown into a heap in the barnyard to be leached by the storms of months before being spread upon the land.

Where pits cannot be provided the manure pile should rest upon a hard, clay bottom, or on a thick layer of peat or vegetable refuse, which acts as an absorbent and prevents the loss of much liquid manure.

The time-honored custom of hauling manure upon the land and of dumping it in small heaps from two to three feet in height, is a wasteful and clumsy practice that should be abandoned by every farmer.

Farm Sewage Disposal.

A simple and effectual way of disposing of the night-soil on a farm is to so construct the closet that the urine will at once drain to a lower level, and there be mixed with an equal quantity of quicklime. The solid excrement should be covered daily with a small quantity of quicklime mixed with a little fine charcoal or peat. Such a receptacle can be made by any farmer at comparatively little cost, and will more than compensate for the care it entails by doing away with ill-smelling odors and the disagreeable and often dangerous task of cleaning vaults, besides furnishing a very rich manurial product for admixture with farm-yard manure or compost. Such receptacle should be made in the form of a shallow drawer or box with an inclined bottom, and should rest upon stout runners like a stone boat or drag, so that, at frequent intervals, it can be drawn by a horse to the manure pile or compost heap.

On the bottom of the drawer should be kept a thin layer of quick-lime mixed with peat, wood-pile dirt, or loam.

As an alkali, soda has no advantage over potash, since the decomposing action of the soda is rarely due to its alkalinity. Potash, if used in the form of wood-ashes, the lime carbonate of the ashes, will neutralize the acid properties of the peat, and the growth of the Nitrate ferment will thus be greatly promoted.

Soda is, in rare instances, needful as a plant food; if needed it would be better economy to use soda ash. In these composts the writer invariably substitutes kainit, or other products of the German mines, for common salt.

How to Save Humus. Sawdust, leaves, cornstalks, tan bark, and all kinds of coarse vegetable materials are more rapidly decomposed by the aid of caustic alkalies than by any other means. Coarse materials, like cornstalks, trimmings from fruit trees, hedges, grape vines, etc., are rich in plant food, and instead of being burned should be composted with potash and lime in separate heaps. More time must be allowed for the decomposition of coarse materials, and they should always be composted in large heaps and kept moist.

Nitrification or Nitration. The process of nitration in the niter-bed, the compost heap, or in the soil is precisely the same. The formation of Nitrates is due to the continuous life and development of a microorganism known as the nitric ferment or nitric bacteria, which lives upon the nitrogenous organic matters, ammonium compounds, and other things present in the soil. The nitric ferment is a microscopic plant somewhat like the yeast used for leavening bread, and for fermenting malt liquors; and under favorable conditions of temperature and moisture, and in the presence of oxygen is propagated with marvelous rapidity in the soil. One of the results of the life of this minute plant is the formation of Nitrates.

Nitration is extremely feeble in winter and at temperatures below 40° F. almost entirely ceases. It is most active at about 98° F. to 99° F., and is more rapid in the dark than in bright sunlight. At temperatures above 100° F. the formation of Nitrates rapidly decreases and at 131° F. entirely ceases. As we have just stated, it has been noticed that the nitric ferment thrives best in the dark, and, hence, one good reason for making compost beds under sheds or in sheltered situations. When so made the conditions for

nitrification are more favorable and the beds are protected from the leaching action of storms.

To ensure rapid nitrification all the food elements required by the nitric ferment must be present. The ash ingredients of plants, phosphates, ammonia, carbonaceous matter, and an excess of oxygen must be present.

Peat containing much copperas, coal-tar, gas-lime containing sulphites and sulphides, kill the ferment. The Nitrate ferment is developed during the slow decay of organic matter in all soils.

How to Make Commercial Valuations.

First, of unmixed chemicals.

Nitrate of Soda.

Multiply the guaranteed per cent. of Nitrate of Soda by 16.47, which gives the per cent. of Nitrogen; multiply the per cent. of Nitrogen thus obtained by the trade value of Nitrogen in the form of Nitrates (15 cents per pound), then multiply the last result by 20, which gives the value per ton.

Example.—A Nitrate of Soda is guaranteed to be 95 per cent. pure; that is, the total impurities in it amount to 5 per cent.: $95 \times 16.47 = 15.64$ per cent. of Nitrogen; 15.64×15 (trade value for 1892) $= 234$ cents, or \$2.34, value of Nitrogen in 100 pounds; $\$2.34 \times 20 = \$46.80$, value per ton.

Sulphate of Ammonia.

Multiply the per cent. of ammonia by .8235, and then multiply the result by the trade value of Nitrogen in ammonia salts, $17\frac{1}{2}$ cents; multiply the result by 20, which gives the value per ton.

Example.—A manufacturer guarantees his sulphate of ammonia to contain 22 per cent. of ammonia: $22 \times .8235 = 18.12$ per cent. of Nitrogen; $18.12 \times 17\frac{1}{2} = 317$ cents, or \$3.17, the value of Nitrogen in 100 pounds of sulphate of ammonia; $\$3.17 \times 20 = \$63.40$, value per ton.

Sulphate of Potash.

Multiply the guaranteed per cent. of sulphate of potash by .54; multiply the result by the trade value for potash in high-grade sulphate (5 cents) and multiply the last result by 20.

Example.—A high-grade sulphate of potash is guaranteed by the manufacturer to contain 45 per cent. of sulphate of potash: $45 \times .54 = 24.30$ per cent. of actual potash; 24.30

$\times$ 5 = 122 cents, or $1.22, the value of actual potash in 100 pounds of sulphate; $1.22 $\times$ 20 = $24.40, value per ton.

Muriate of Potash (Chloride). Multiply the guaranteed per cent. of muriate (chloride) by .63; then multiply the result by the trade value for potash in the form of muriate (4½ cents per pound for 1892), and multiply the last result by 20.

Example.—A muriate of potash is guaranteed to contain 80 per cent. of muriate (chloride): 80 $\times$ .63 = 50.40 per cent. of actual potash; 50.40 $\times$ 4½ cents = 227 cents, or $2.27, the value of actual potash in 100 pounds of sulphate; $2.27 $\times$ 20 = $45.40, value per ton.

Second. How to make a commercial valuation of a fertilizer from a guarantee-analysis as given by manufacturers.

The statements of guarantee-analysis as used by manufacturers differ considerably in form, and the amount of each constituent is usually stated as being between two more or less widely varying limits. Thus, we are offered a fertilizer which in the guaranteed analysis is stated to contain: Ammonia, from 2 to 3 per cent.; available phosphoric acid, 8 to 10 per cent.; insoluble phosphoric acid, 2 to 3 per cent.; and potash, *equal* to 3 to 5 per cent. In estimating the valuation from such form of statement of analysis the *lower numbers* should be always used, for the manufacturer is held legally only to the lower figures given in the guarantee. The per cent. of Nitrogen in the guarantee-analysis is most usually given in the form of ammonia, and the per cent. of potash may be given in the form of sulphate or muriate (chloride) of potash. When the per cent. of organic Nitrogen is given multiply the per cent. of Nitrogen by the trade value adopted for organic Nitrogen in mixed fertilizers. But if the Nitrogen is stated in the form of ammonia, multiply the guaranteed per cent. of ammonia by .8235, which will give the per cent. of actual Nitrogen; then multiply the result by the trade value for organic Nitrogen in mixed fertilizers, which will give the value of the Nitrogen in 100 pounds of fertilizer. Thus, in the fertilizer given above the per cent. of ammonia in the guaranteed analysis is from 2 to 3 per cent. As directed, we take the lower number, 2 per cent.: 2 $\times$ .8235 = 1.65 per cent. of Nitrogen; 1.65 $\times$ 15½ cents = 25.58 cents.

The per cent. of available phosphoric acid is guaranteed to be from 8 to 10 per cent.: $8 \times 4\frac{1}{2}$ cents $= 36$ cents. Insoluble phosphoric acid: 2×2 cents $= 4$ cents.

The guaranteed per cent. of potash is 3 to 5 per cent. But the statement of analysis does not tell the form in which the potash is present. All we know is that there is from 3 to 5 per cent. of actual potash contained in the fertilizer, so we will give ourselves the benefit of the doubt and assume the potash to be in the form of muriate (chloride): $3 \times 4\frac{1}{2}$ cents $= 13\frac{1}{2}$ cents.

We now have the value in cents of the Nitrogen, available and insoluble phosphoric acid, and potash. Add these together and the sum is the value in cents of the total fertilizing constituents in 100 pounds of fertilizer. This sum multiplied by 20 gives the value in cents of one ton.

Example:—

Nitrogen	$1.65 \times 15\frac{1}{2} = 25.5$	cents.
Available phosphoric acid	$8 \times 7\frac{1}{2} = 36.0$	"
Insoluble phosphoric acid	$2 \times 2 = 4.0$	"
Potash	$3 \times 4\frac{1}{2} = 13.5$	"
Total value of 100 pounds	79.0	cents.

$79 \times 20 = 1580$ cents, or $15.80 value per ton.

If the potash is given in the form of sulphate we find the equivalent of actual potash by multiplying the per cent. of sulphate by .54 and the result by the trade value, $5\frac{1}{2}$ cents. If the potash is given in the form of muriate (chloride), multiply the per cent. of muriate (chloride) by .63 and the result by the trade value, $4\frac{1}{2}$ cents.

Example 1.—A manufacturer's guarantee-analysis is 8 to 10 per cent. of potash as sulphate: $8 \times .54 = 4.32$ per cent. of actual potash; $4.32 \times 5\frac{1}{2}$ cents $= 23.7$ cents, the trade value of actual potash as sulphate in 100 pounds of fertilizer.

Example 2.—A manufacturer's guarantee-analysis is 6 to 8 per cent. of potash as muriate (chloride): $6 \times .63 = 3.78$ per cent. of actual potash; $3.78 \times 4\frac{1}{2} = 17.0$ cents, trade value of actual potash as muriate in 100 pounds of fertilizer.

Summary of the methods heretofore used in converting one chemical compound into an equivalent of another chemical compound.

(*a*) To change Nitrogen into an equivalent amount of ammonia, multiply the given amount of Nitrogen by 1.214.

(*b*) To convert ammonia into an equivalent amount of Nitrogen, multiply the given amount of ammonia by .8235.

(*c*) To convert a guaranteed per cent. of Nitrate of Soda to an equivalent of Nitrogen multiply the per cent. of Nitrate of Soda by 16.47.

(*d*) To convert a guaranteed per cent. of sulphate of potash to an equivalent of actual potash multiply the per cent. of sulphate by .54.

(*e*) To convert muriate (chloride) of potash to an equivalent amount of actual potash, multiply the per cent. of muriate (chloride) by .63.

(*f*) To convert actual potash to an equivalent per cent. of sulphate of potash, multiply the per cent. of actual potash by 1.85.

(*g*) To convert potash to an equivalent per cent. of muriate (chloride) of potash, multiply the per cent. of actual potash by 1.585.

We now have the data for estimating the commercial values of fertilizers from the guarantee-analyses as usually published by manufacturers. We may in a few moments calculate the comparative commercial values of different trade-brands, and be governed in buying by their actual commercial values and by the requirements of our soil and the crops to be grown. Or, if we have an eye to saving from twenty to thirty per cent. by mixing our own fertilizers during the idle winter months, when we can usually buy agricultural chemicals cheaper than at any other season of the year, we can now proceed intelligently and prepare chemical manures containing just such percentages of Nitrogen, phosphoric acid, and potash, as soil and crop requirements demand.

We ascertain the cheapest source of raw materials, estimate our wants and buy for cash on guaranteed analyses. Or, better still, by co-operating with several other farmers we purchase, at wholesale, sufficient raw materials for our combined use. With a few hoes and shovels, a good-sized ash sieve, and an even barn floor we are ready for work.

Mixing Raw Materials.

We proceed to spread the weighed raw materials in thin layers on the barn floor, building them layer upon layer to a height convenient for easy manipulation; then intimately mix with hoes by working the piles over from the outward edge inward,

pass the mixed materials through the sieve, and having secured an even admixture, store the finished materials away in bags or barrels until needed for use.

Examples.—We want a complete high-grade fertilizer for general use, and decide it shall contain from 4 to 5 per cent. of Nitrogen, 8 to 9 per cent. of phosphoric acid, and from 6 to 7 per cent. of potash. In making an approximate estimate of our wants we will take the higher numbers given. Then for one ton we want—Nitrogen 5 per cent. (or 5 pounds in each 100 pounds of fertilizer) $\times$ 20 = 100 pounds, phosphoric acid (available) 9 per cent. $\times$ 20 = 180 pounds, and potash 7 per cent. $\times$ 20 = 140 pounds.

The tables of analyses in the appendix have been carefully consulted before purchasing and our raw materials have been bought upon guaranteed analyses, are of good merchantable quality and are up to the standard of guarantee. We conclude to get our three essential components from a variety of materials and proceed thus:

Material, Lbs.		Nitrogen, Lbs.	Phosphoric Acid, Lbs.			Potash, Lbs.
			Available.	Insoluble.	Total.	
200	**Nitrate of Soda**.......	31.50	.....	.....	.....	.....
250	Sulphate of ammonia....	51.25	.....	.....	.....	.....
100	Dried blood............	10.52	.....	1.91	1.91	.....
350	Dissolved bone meal.....	9.10	47.35	14.24	61.59	.....
800	Dissolved bone-black....	.....	133.60	2.40	136.00	.....
200	Muriate of potash (chloride)..................	.....	.....	.....	.....	104.92
100	Sulphate of potash (high grade)...............	.....	.....	.....	.....	38.60
2,000	Total quantities in 1 ton..	102.37	180.95	18.55	199.50	143.52
	Per cent. in 1 ton.......	5.11	9.04	.92	9.97	7.17

Now let us suppose that out of these same materials we wish to make a fertilizer containing from 1 to 2 per cent. of Nitrogen, 6 to 8 per cent. of phosphoric acid, and from 2 to 3 per cent. of potash. We have four ingredients that supply Nitrogen, namely, Nitrate of Soda, sulphate of ammonia, dried blood, and dissolved bone meal, and they supply it in the three forms of nitric acid, ammonia, and organic Nitrogen.

We want from 20 to 40 pounds of Nitrogen, 120 to 160 pounds of phosphoric acid, and from 40 to 60 pounds of potash. In compounding our formula we will take the higher number for Nitrogen (40 pounds), and will take the Nitrogen in about equal proportions; that is, 10 pounds of Nitrogen from each of the four nitrogenous constituents. We begin with Nitrate of Soda, containing 15.75 pounds of Nitrogen in each 100 pounds of the Nitrate. Now, how many pounds of Nitrate of Soda must we have to get 10 pounds of Nitrogen? It is a very simple calculation; since in 100 pounds there are 15.75 pounds of Nitrogen there must be in 1 pound of Nitrate of Soda the one-hundredth part of 15.75 pounds, or .1575 pounds of Nitrogen. Hence, we must have about 63½ pounds of Nitrate of Soda.*

We make a similar calculation for sulphate of ammonia, as follows: 100 pounds of sulphate of ammonia contain 20.50 per cent. of Nitrogen. Therefore, 1 pound of sulphate of ammonia contains the one-hundredth part of 20.50, or .2050, and we have .2050 ÷ 10,000 = 48.7 pounds, or we simply take 50 pounds of sulphate of ammonia, which contain 10.25 pounds of Nitrogen. Like calculations for all the raw materials are made, and, after estimating the required quantities for all the constituents, we have:

Material, Lbs.		Nitrogen, Lbs.	Phosphoric Acid, Lbs			Potash, Lbs.
			Available.	Insoluble	Total.	
63½	**Nitrate of Soda**......	10.00	.....	.....	.....	.....
50	Sulphate of ammonia....	10.25	.....	.....	.....	.....
100	Dried blood............	10.52	.....	.....	1.91	.....
400	Dissolved bone meal.....	10.40	54.12	16.28	70.40	.....
515	Dissolved bone-black....	.....	86.00	1.54	87.54	.....
100	Sulphate of potash (high grade)...............	.....	.....	.....	.....	38.60
45	Muriate (chloride)......	.....	.....	.....	.....	23.60
1,273½	Total quantities in 1 ton..	41.17	140.12	17.82	159.85	62.20
	Per cent. in 1 ton.......	2.05	7.00	0.89	7.99	3.11

*.1575 ÷ 10,000 X 63½ pounds.

We have the required percentages of Nitrogen, available phosphoric acid, and potash, but instead of 1 ton of 2,000 pounds we have only 1,273½ pounds of materials. We may add 721½ pounds of land plaster, peat, coal ashes, or loam to make up the ton.

This formula illustrates the question often raised by farmers: "Why does the sum of the fertilizing constituents in the analysis of a fertilizer amount to so much less than the total weight of the fertilizer, and what is used by the manufacturer to make up the difference?" We find that when the percentages of Nitrogen, total phosphoric acid, and potash are added together, the sum of their weights range between 16 and 30 per cent. of the total weight, and that in each ton of fertilizer there is from 70 to 84 per cent. of something else. This great difference is not due to dishonesty on the part of manufacturers or dealers in agricultural chemicals. The essential elements are always combined with other substances which often are of no use whatever to growing crops. Thus, in 100 pounds of Nitrate of Soda we have only 15.75 pounds of Nitrogen and 84.25 pounds of sodium, oxygen, and moisture, and so it is with all other constituents of fertilizers—the greater part of the weight is made up of moisture, dirt, etc. In many States of the Union there is much greater protection against fraud in buying commercial fertilizers than in the purchase of food or clothing.

But commercial fertilizers or raw materials, for mixing, should never be bought except upon guaranteed analyses, and with strict regard to soil requirements and the character of the crop to be fed.

In the above formula we might slightly change the percentages of fertilizing constituents, and probably get a better crop effect by the change. We might drop out the muriate of potash and reduce the sulphate of potash to 50 pounds, and then substitute 821½ pounds of unleached wood ashes for the sulphate and muriate of potash left out. In the wood ashes there will be 45.21 pounds of potash and 15.20 pounds of phosphoric acid. Our formula would then stand:

Material, Lbs		Nitrogen, Lbs.	Phosphoric Acid, Lbs.			Potash, Lbs.
			Available.	Insoluble.	Total.	
$63\frac{1}{2}$	**Nitrate of Soda**	10.00	.....	.....	.....	.....
50	Sulphate of ammonia....	10.25	.....	.....	.....	.....
100	Dried blood............	10.52	.....	.....	1.91	.....
400	Dissolved bone meal.....	10.40	54.12	16.28	68.40	.....
515	Dissolved bone-black....	.....	86.00	1.54	87.54	.....
50	Sulphate of potash (high grade)...............	.....	.....	.....	.....	19.30
$821\frac{1}{2}$	Wood-ashes (unleached)	.....	.....	.....	15.20	45.21
2,000	Total quantities in 1 ton.	41.17	140.12	17.82	173.05	64.51
	Per cent. in 1 ton.......	2.05	7.00	0.89	8.65	3.22

The Unit System.

In the wholesale fertilizer trade some raw materials are bought and sold on the "*unit system.*" The unit is 1 per cent., or 20 pounds per ton.

Thus, a lot of dried blood, containing 10.50 per cent. of Nitrogen, equivalent to 12.75 per cent. of ammonia; is said to contain $12\frac{3}{4}$ units of ammonia, and, quoted at \$2.50 per unit, a ton will cost: $12\frac{3}{4} \times \$2.50 = \$31.87\frac{1}{2}$.

A quotation of \$1.50 per unit of available phosphoric acid means \$1.50 for each *20 pounds* contained in the material quoted.

Illustration.—A manufacturer offers dissolved bone black guaranteed to contain 16 units of available phosphoric acid, at \$0.70 per unit: $16 \times \$0.70 = \$11.20$ per ton.

Materials Used in Making Commercial or Chemical Manures.

Nitrate of Soda or Chili Saltpetre.

Nitrate of Soda or Chili saltpetre occurs in vast deposits in the rainless districts on the West coast of South America, chiefly in Peru, Chili, and Bolivia, from whence it is imported to this country for use in chemical manufacture and in agriculture. As imported into the United States, Nitrate of Soda usually contains from fifteen to sixteen per

cent. of Nitrogen. Nitrate of Soda resembles common salt, with which and sodium sulphate it is often adulterated. This salt is at once available as a *direct fertilizer*, and being very soluble in water is therefore liable to be washed from soils. Whenever practicable its hould be applied as a top-dressing to growing crops, and if possible the dressings should be given in two or three successive rations.

Nitrate of Soda is usually applied at the rate of from 100 to 200 pounds per acre on land previously dressed with farm-yard manure. To secure an even distribution, the Nitrate should be previously well mixed with from three to five parts of fine loam or sand.

Much has been said and written about Nitrate of Soda exhausting the soil. This is all a mistake and is the outcome of incorrect reasoning. Nitrate of Soda does not exhaust soils. It does promote the development of the leafy parts of plants, and its effects are at once noticeable in the deep, rich green, and vigorous growth of crops. The growth of plants is greatly energized by its use, for the Nitrate in supplying an abundance of nitrogenous food to plants, imparts to them a thrift and vigor which enables their roots to gather in the shortest time the largest amount of other needed foods from a greater surface of surrounding soil. Nitrate of Soda adds nothing of value to the soil but nitric acid. The thirty-seven to forty per cent. of soda which it contains is practically of no use to agricultural plants. In the increased crop contained by its use there must necessarily be more potash and phosphoric acid than would have been contained in a smaller crop on which the Nitrate of Soda had not been used. The increased consumption of phosphoric acid and potash is due to the increase in the weight of the crop. The office of the Nitrate is to convert the raw materials of the soil into a crop; for we obtain by its use, as Dr. Griffiths has tersely said, "the fullest crop with the greatest amount of profit, with the least damage to the land."

How Used.

On cereals Nitrate of Soda should be used *alone* or mixed with dry superphosphate and applied as a top-dressing.

On grass lands it may be applied as a top-dressing at the rate of 150 to 200 pounds per acre.

Some of our most successful onion growers use *Nitrate of Soda* at the rate of from 500 to 700 pounds per acre, applying the *Nitrate* in three successive top-dressings, the last ration being given when the crop is about half grown.

From what is known of the fertilizing action of Nitrate of Soda, the following conclusions may be safely drawn, viz.:

First. The Nitrate of Soda is, in most cases, a reliable manure for cereals, roots and grasses, increasing the yield over other nitrogenous manures.

Second. Many crops grown with Nitrate of Soda mature from one to two weeks earlier than when grown with other nitrogenized manures.

Third. The best results are obtained by applying the Nitrate to crops in fractional top-dressings during the active stages of growth.

Fourth. Crops grown with Nitrate of Soda generally have a higher feeding value than those grown with other forms of Nitrogen.

Fifth. Crops grown with Nitrate of Soda seem to resist the attacks of parasitic organisms better than those grown without its aid.

Sixth. Nitrate of Soda does not exhaust the land.

Phosphatic Guano.

Although in the phosphatic guanos the Nitrogen compounds and the potash which they originally contained have been washed out by the rains, much of the phosphoric acid is in a form that can be more readily dissolved by the roots of plants and by the carbonic acid water of the soil than is the case with many of the finely ground rock-derived phosphates. Phosphatic guanos, when finely powdered, do excellently for moist grass lands and in soils rich in humus, and are also excellent materials for working into composts or manure heaps. But the phosphatic guanos, of which the Jarves, Baker, and Howland Islands are types, are rarely applied directly to the soil. They are chiefly valuable for the phosphate of lime which they contain, and are used almost altogether in the manufacture of superphosphates.

The phosphoric acid of natural phosphates, when finely enough powdered, is somewhat soluble in weak acids, and hence can be readily absorbed by the acid secretions of the roots of plants.

This manure is specially recommended for peat, clay, and sandy soils, also for moorlands and wet meadows.

It can be mixed with Nitrate of Soda, but such mixtures should only be made just before spreading on the land; this phosphate must not be mixed with sulphate of ammonia, as a part of the ammonia will be liberated and lost. English authorities recommend that basic slag phosphate, when used alone, be applied from six to eight weeks earlier than superphosphate, because of the greater solubility of the superphosphate; and that the basic phosphate be used in preference to superphosphate on wet, peaty, and marshy soils on account of its containing an excess of free lime, which neutralizes the organic acids of the soil. Dr. Paul Wagner recommends four and one-half hundredweight (five hundred and four pounds) of basic slag phosphate per acre for general crops.

Economy in the Purchase of Fertilizers.

Home Mixtures.

Economy in the purchase of fertilizing materials or of agricultural chemicals depends not only on the price paid per pound or per ton, but also on the relation existing between the price paid and the amounts and forms of the Nitrogen, phosphoric acid, and potash furnished. To illustrate, we will assume that two fertilizers, both made from the best class of materials, are offered by a manufacturer at thirty dollars and thirty-five dollars per ton. The first is guaranteed to contain three per cent. of Nitrogen, seven per cent. of available phosphoric acid, and three per cent. of potash. The second is guaranteed to contain five per cent. of Nitrogen, ten per cent. of available phosphoric acid, and seven per cent. of potash.

We have but to calculate the commercial values of these fertilizers to ascertain their true relation to the prices asked by the manufacturer. By simply multiplying the actual content of Nitrogen, phosphoric acid, and potash by the trade values for these constituents in mixed fertilizers, we find that there is an actual difference of nearly $14 in their commercial values, whereas the difference in price made by the manufacturer is only $5.

No. 1 has a commercial value of less than $24, while No. 2 has a commercial value of nearly $37 per ton; or in No. 1 we are asked $1.50 per 100 pounds for a fertilizer worth about $1.16, and in No. 2 we are asked $1.75 per 100 pounds for a fertilizer worth $1.85.

The fertilizer materials in the higher priced fertilizers are about thirty-three per cent. cheaper than those in the lower priced article.

As a general rule *the more concentrated the form of fertilizing materials in commercial fertilizers, or the higher the grade of unmixed raw materials purchased by the farmer for home mixing, the greater will be the saving in actual cost.*

The higher the grade of materials the less will be the expense for freight, mixing, and spreading upon the land.

There are these decided advantages about the mixing of materials at home, viz., each raw material can be separately examined, and if there is any cause for suspecting inferior forms of Nitrogen, phosphoric acid, or potash, samples may be sent to the State Experiment Station for analysis. The detection of error or fraud is more certain and much easier in unmixed raw materials than in mixed fertilizers. Another important advantage of home-mixing is the opportunity afforded the intelligent farmer to adapt the composition of a fertilizer to the special soil requirements of his land and to the wants of the crop to be grown. And, lastly, home mixtures have, as a rule, proved to be much cheaper than ready-made fertilizers. However, the economy of home-mixing should in every instance be determined by actual calculation.

Nitrogen, phosphoric acid, and potash, as we have already seen, are necessary for the complete development of farm crops, and are the constituents most likely to be deficient in cultivated soils; different crops have different capacities for consuming these plant foods, so that when no increase in crop production follows a rational application of one, two, or all three of these constituents the soil evidently contains them in sufficient stores to develop crops to limitations fixed by season and existing climatic conditions. By a careful study of the capacities of different crops for using Nitrogen, phosphoric acid, and potash, we may, within reasonable limits, approximate the quantities, which, under average conditions of crop, soil, and season, should be

restored to the land to balance the consumption of growing crops.

Tables exhibiting the average amounts of Nitrogen, phosphoric acid, and potash found profitable for different crops are given on pages 163, 164, 172.

In using complete fertilizers, or in special crop feeding, it should be borne in mind that lands in a high state of cultivation generally respond to heavy fertilization with much greater immediate profit than those of ordinary fertility.

Home-Mixing.

The following formulas, together with the analyses and valuations, are taken from the Twelfth Annual Report of the New Jersey State Agricultural Experiment Station for 1891.

They prove most conclusively that farmers can make even mixtures of raw materials which in mechanical condition compare favorably with the best manufactured brands of complete fertilizers, and that the cost of mixing by the manufacturers may be saved without increasing the cost of farm labor.

The results also show that in this particular instance there was a total difference of thirty-one per cent. in cost in favor of home-made mixtures.

"In making these mixtures two important points were taken into consideration. First, that the *value* of a complete fertilizer depends upon the kind and quality of the essential ingredients, Nitrogen, phosphoric acid, and potash contained in it; and second, that the higher the grade of the materials used in making the mixture the less will be the expenses of freight and handling per pound of essential ingredients.

"High grade materials were used in the preparation of all of these mixtures, and the different combinations were, as a rule, adopted after a careful study of the plant-food requirements of the soil for different crops.

"Chemical analyses were made of all the materials used in the mixtures:

Formulas.

For General Crops:

Nitrate of Soda	200 lbs.
Dried blood	200 "
Ground bone	400 "
Superphosphate	1,000 "
Sulphate of potash	200 "
	2,000 lbs.

For Potatoes: I.

Nitrate of Soda	100 lbs.
Dried blood	200 "
Ground fish	200 "
Ground bone	400 "
Superphosphate	800 "
High-grade sulphate of potash	300 "
	2,000 lbs.

II.

Nitrate of Soda	250 lbs.
Tankage	500 "
Bone-black superphosphate	800 "
High-grade sulphate of potash	450 "
	2,000 lbs.

III.

Nitrate of Soda	250 lbs.
Sulphate of ammonia	400 "
Bone-black superphosphate	800 "
Double sulphate of potash and magnesia	675 "
Land plaster	500 "
	2,625 lbs.

For Peach Trees:

Nitrate of Soda	300 lbs.
Dissolved bone	400 "
South Carolina rock superphosphate	700 "
Muriate of potash	600 "
	2,000 lbs.

"The mechanical condition of these mixtures was all that could be desired; they were fine, dry, and in every respect equal to *the best brands of mixed fertilizers on the market in the State.*"

What Was Shown by the Analyses.

"The main objects of the analyses were to determine, first, whether farmers using the ordinary tools and labor of the farm could make even mixtures of the materials used, and, second, whether in the cost of actual plant food home

mixing presented any advantages over the usual method of buying manufactured fertilizers.

"In the following table the actual composition of the different mixtures is compared with the calculated composition of a perfect mixture in each case, the analyses of the raw materials and the weights used in the formulas serving as a basis for the calculation. The estimated commercial value of the mixture is also compared with the estimated value of an even mixture of the materials used.

Table of Analyses and Guarantees.

Station Number.	Total Nitrogen.			Total Phosphoric Acid.			Potash.			Valuation at Station's Price.	
	Guaranteed	Found.	Difference	Guaranteed.	Found.	Difference.	Guaranteed.	Found.	Difference.	Mixture	Materials Used
3960	4.01	4.01	.....	13.34	13.69	+0.35	5.43	5.40	—0.03	$35.70	$36.34
4002	4.43	4.21	—0.22	10.69	11.45	+0.76	7.65	6.96	—0.69	33.92	37.10
3986	5.12	4.92	—0.20	7.00	7.20	+0.20	11.16	11.29	+0.13	40.03	40.16
3978	3.55	3.87	+0.32	9.50	9.57	+0.07	11.25	11.79	+0.54	39.19	36.18
4246	4.59	4.52	—0.07	4.73	5.04	+0.31	6.86	7.22	+0.36	32.49	30.92

"The plus, +, and minus, —, signs in the difference column, indicate the percentage more or less found by analyses than was guaranteed.

"There is a very close agreement between the calculated and actual composition of these mixtures; the widest variation is 0.32 per cent. for Nitrogen, 0.76 per cent. for phosphoric acid, and 0.69 per cent. for potash. In home-made mixtures the value of exactness in composition depends very largely upon the value of the relative proportions of the plant food applied to the soil for the different crops. A pound per acre, more or less, of either Nitrogen, phosphoric acid, or potash would probably not be observed in the results secured from their use. Taking the widest variation in the above mixture it would require 313 pounds to make a difference of one pound in the Nitrogen, 133 pounds in the phosphoric acid, and 145 pounds in the potash. The mixtures do contain practically the amount and proportion of plant food that they were intended to furnish, and, *therefore, show that farmers are able to make even mixtures of such raw materials as the market affords.*

"A comparison of the commercial value per ton of the materials used with that of an actual mixture also confirms the results of analyses, the average difference between the two values being but thirteen cents per ton. This is a severe test, since in three cases out of the five the three forms of the expensive element Nitrogen were used, each of which has a different commercial value, and also because in three mixtures ground bone or tankage was used, materials which in themselves are valued in a different manner than when they are used in a mixed fertilizer.

Valuation.

"In Nos. 3960 and 4002 the cost of raw materials included freight charges to point of consumption; in the others the average cost of freight was $1.00 per ton. The cost of mixing was variously estimated, ranging from 50 cents to $1.50 per ton. In the table showing cost and value of the mixtures $1.00 per ton has been assumed as the average cost of mixing.

Station Number.	3960	4002	3986	3978	4246	4207
Cost per ton...........	$29.06	$30.60	$36.76	$33.00	$27.74	$30.10
Freight and mixing.....	1.00	1.00	2.00	2.00	2.00	2.00
Total cost per ton......	30.06	31.60	38.76	35.00	29.74	32.10
Station's value.........	35.70	33.92	40.03	39.19	32.49	33.45
Value exceeds cost.....	5.64	2.32	1.27	4.19	2.75	1.35

"The average value per ton of these mixtures is $2.92, or 8.9 per cent. greater than their cost at point of consumption. This sum, while worthy of careful consideration by the farmers, by no means represents the actual saving in the cost of plant food that this method of buying offers over the usual haphazard method of buying on credit from small dealers and without regard to the source of materials used or reliability of the manufacturer. The following results shown by study of the analyses of complete fertilizers, made in 1890, clearly illustrate this point, viz., that the value per ton of the average of over 200 brands of complete fertilizers was $28.37 and the average selling price $34.64, a difference of $6.27 per ton, or a cost of 22.1 per cent. greater than the value; this added to the 8.9 per cent. would make a total

difference in favor of home mixtures of 31 per cent.; in other words, *an amount of plant food in a mixture that would cost on the average $100 when bought in the form of raw materials and mixed at home would, on the average, cost $131 when bought in the usual manner in the form of manufactured brands.*

"The best forms of fertilizing materials are used in the preparation of these formulas, as they will probably be found to be the cheapest in the majority of cases. These are, as a rule, in good mechanical condition, and can be bought direct from the leading dealers or manufacturers, and should in all cases be accompanied by a guaranteed composition. It is important that the materials should be evenly mixed. This can be easily done by forming on the barn floor or other dry and level place, a series of layers of the different materials, and working the heap over from the edge outward, breaking all the lumps in the process; a few turnings will suffice to answer the purpose. Screening is also advisable if suitable apparatus is at hand. It is not claimed that the buying of raw materials and mixing at home is the best and cheapest method of getting fertilizers under all conditions; however, the important points in favor of the system will bear repeating, viz.:

"1. That a definite knowledge of the quality of the materials is secured; and

"2. That where farmers know what they want, and unite in purchasing car lots, there is a decided saving in the cost of plant food."

The elaborate investigations of the New Jersey Experiment Station plainly indicate that there is a decided saving in the cost of plant food by buying the unmixed raw materials and mixing them at home.

Farmers and farmers' clubs should give the method a practical trial. They will have the ready co-operation of their State experiment stations in so far as it may be necessary to test by analyses the materials to be used.

A matter of paramount importance in purchasing raw materials for home mixture is to take advantage of market fluctuations in laying in a season's supply. Marked variations in cost occur, and a saving of from 10 to 20 per cent. is often the result of buying early in the year before the spring work has fully begun, and there is no better time for mixing than during the idle winter months.

Two Good Home Mixtures.

I. Mixture for General Use. (Connecticut Experiment Station.)

Dissolved bone-black	834 lbs.
Tankage	666 "
Sulphate of ammonia	208 "
Muriate of potash	292 "
	2,000 lbs.

II. Mixture for General Use. (Connecticut Experiment Station.)

Tankage	450 lbs.
Sulphate of ammonia	170 "
Dissolved bone-black	1,000 "
Muriate of potash	280 "
Bone (meal)	100 "
	2,000 lbs.

"The *actual cost* in many, if not all, of these cases has been very considerably reduced by special rates which are given where a number of farmers give a cash order for a car lot or more.

"The average cost of materials in these home-mixed fertilizers has been thirty-four dollars and twenty-three cents per ton delivered at the purchaser's freight station. Two dollars will fully cover the cost of screening and mixing. (From a dollar to a dollar and a half is the estimate of those who have done the work.) The average valuation has been thirty-four dollars and eighty-five cents per ton. On the basis of these figures the average difference between cost and valuation has been less than six per cent. In factory-mixed goods it has averaged in round numbers eighteen per cent.

"There is no longer any question as to the expediency of home-mixing in many cases. From such raw materials as are in our markets, without the aid of milling machinery, mixtures can be and are annually made on the farm which are uniform in quality, fine and dry, and equal in all respects to the best ready made fertilizers."

Amounts of Manure Produced by Farm Animals.

From Bulletin 27, Cornell University Agricultural Experiment Station.

Cows.

In the experiment with cows, eighteen Jersey and Holstein grades in milk were kept in their places during the whole twenty-four hours,

and the manure carefully collected as it was excreted, and a sufficient quantity of bedding and absorbents of known composition and weight were used to make the collection complete.

The cows consumed 114 pounds of hay, 893 pounds of ensilage, 186 pounds of beets, and 154 pounds of a mixture of 12 parts wheat bran, 9 parts cotton-seed meal, 3 parts corn meal, and 1 part malt sprouts. The other details of the experiment are shown in the table:

	Eighteen Cows for One Day.	Average Per Cow Per Day.
Weight of cows, pounds	20,380	1,132
Food consumed, pounds	1,347	75
Water drunk, pounds	876	49
Total excretion, pounds	1,452.5	81
Nitrogen, pounds	7.35	.41
Phosphoric acid, pounds	5.01	.28
Potash, pounds	7.40	.41
Value of Nitrogen	$1.10	$0.06
Value of phosphoric acid	.35	.02
Value of potash	.33	.02
Total value	1.78	.10

Composition of the mixed excrement:

Nitrogen	.51	per cent.
Phosphoric acid	.35	"
Potash	.51	"
Value per ton	$2.46	

A few days later a second trial was made with four of the same cows and the solid and liquid excrement carefully collected and analyzed separately. The conditions of food, water, etc., were almost identical.

	First Trial.	Second Trial.
Average weight	1,132	1,178
Average food eaten	75	76
Average water drunk	49	40
Average total excrement voided	81	82

The four animals yielded in twenty-four hours 255 pounds of solid and 72.25 pounds of liquid excrement, which had the following composition:

	Solid, Per Cent.	Liquid, Per Cent.	Mixed, Per Cent.
Nitrogen	.26	1.32	.49
Phosphoric acid	.28	....	.22
Potash	.20	1.00	.38
Value per ton	$2.08		

The average of the two trials shows that well-fed cows, yielding milk heavily, may be counted upon to return nearly ten cents' worth of valuable fertilizing materials per day, and the last trial shows that the liquid excrement is of equal value with the solid.

Horses. The determination of the amount of excrement was made by carefully collecting the manure made by the ten horses in the University barn during the time they were in the stable, for a period of eleven days, including one Sunday. During this time the bedding used was also weighed and separately analyzed. The horses were mostly grade draft horses of about 1,400 pounds weight, doing heavy work and liberally fed on oats and hay. During the eleven days of the experiment 3,461 pounds of clear excrement of the following percentage composition was voided:

Nitrogen	.47	per cent.
Phosphoric acid	.39	"
Potash	.94	"
Value per ton	$2.79	

The amount and value of the fertilizing materials would, therefore, be:

	10 Horses for 11 Days.	Average per Horse per Day.
Nitrogen, pounds	16.27	.15
Phosphoric acid, pounds	13.50	.12
Potash, pounds	32.53	.30
Nitrogen, value	$2.44	$0.02
Phosphoric acid, value	.81	.01
Potash, value	1.46	.01
Total	$4.71	.043

The horses, therefore, returned in the manure during the time that they were in the stable rather more than four cents each per day, in about thirty-two pounds of excrement.

Sheep. For this trial, tight galvanized iron pans, covering the whole surface of the pen, were used; the sheep were kept continuously upon them, and enough weighed straw bedding of known composition was used to keep them dry and clean. The sheep were grade Shropshires, of medium size, and were fed on grain, beets, and hay. The experiment lasted for thirty-three and two-thirds days with three sheep, during which time 923 pounds

of clear excrement of the following percentage composition were obtained:

Nitrogen	1.00	per cent.
Phosphoric acid	.08	"
Potash	1.21	"
Value per ton	$4.19	

The other details of the experiment were as follows:

	3 Sheep for 33⅔ Days.	Average per Sheep per Day.
Weight of sheep	426	142
Food consumed	536	5.3
Water drunk	765	7.5
Total excrement	723	7.2
Nitrogen, pounds	7.21	.071
Phosphoric acid, pounds	.60	.005
Potash, pounds	8.74	.086
Nitrogen, value	$1.08	$0.01
Phosphoric acid, value	.04	.0004
Potash	.39	.004
Total value	$1.51	$0.015

The most striking thing in regard to the sheep manure is the extremely low percentage of phosphoric acid. It will be noted that we obtained, in valuable fertilizing materials, about one and one-half cents' worth per sheep per day.

Swine.

The determinations of the amount of manure produced by swine were made in the same general way as the sheep, *i.e.*, by keeping the swine continuously upon tight galvanized iron pans and weighing and analyzing the bedding separately. Two determinations were made with two lots of swine fed on different rations; one lot, known as the carbonaceous lot, was fed nothing but corn meal; the other lot, known as the nitrogenous lot, was fed a ration of two parts corn meal and one part flesh meal. It will be noted that the excrement differed very materially both in amount and quality, as is shown by the following analysis:

	Nitrogenous, Per Cent.	Carbonaceous, Per Cent.	Average, Per Cent.
Nitrogen	.92	.74	.83
Phosphoric acid	.06	.01	.04
Potash	.64	.58	.61
Value per ton	$3.41	$2.94	$3.18

Other Details of the Experiment.

	Nitrogenous. Four Pigs in Seven Days.	Carbonaceous. Four Pigs in Seven Days.	Average. Four Pigs in Seven Days.	Average. Per Pig Per Day.
Weight of swine	600.	426.	513.	128.
Food consumed	122.	78.	100.	3.6
Total excrement	146.	48.	97.	3.5
Nitrogen	1.34	.36	.85	.03
Phosphoric acid, pounds	.09	.007	.05	.002
Potash, pounds	.93	.28	.61	.02
Nitrogen, value	$0.20	$0.05	$0.13	$0.005
Phosphoric acid, value	.006	.005	.005	....
Potash, value	.04	.01	.03	.001
Total value	.25	.07	.16	.006

Summary.

	Value Per Ton.	Value Per Animal Per Day.	Value Per Thousand Pounds Live Weight Per Day.	Value Per Thousand Pounds Live Weight Per Year.
Horse*	$2.79	$0.044	$0.031	$11.47
Horse†	....	.073	.052	19.12
Cows	2.27	.093	.082	29.82
Sheep	4.19	.015	.106	38.55
Swine	3.18	.006	.047	17.11

Analyses of Commercial Fertilizing Materials.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid. Available.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total.
I. Phosphatic Manures.						
Apatite	....	....	....	....	....	36.08
Bone ash	7.00	....	....	....	....	35.89
Bone-black	4.60	....	....	....	....	28.28
Bone-black (dissolved)	....	....	....	16.70	0.30	17.00

* Manure voided while at work not included.
† Total excrement calculated on the basis that three-fifths was collected in the stable.

Analyses of Commercial Fertilizing Materials. *Continued.*

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid. Available.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total.
I. Phosphatic Manures.—Continued.						
Bone meal	7.47	4.12	....	8.28	15.22	23.50
Bone meal (free from fat)	....	6.20	....	....	....	20.10
Bone meal (from glue factory)	....	1.70	....	....	....	29.90
Bone meal (dissolved)	....	2.60	....	13.53	4.07	17.60
Caribbean guano	....	....	....	....	....	18.90
Cuban guano	24.27	1.67	....	....	....	13.35
Mona Island guano	12.52	0.76	....	7.55	14.33	21.88
Navassa phosphate	7.60	....	....	....	....	34.27
Orchilla guano	7.31	....	....	....	....	26.77
Peruvian guano	14.81	7.85	2.61	8.36	6.90	15.26
S. Carolina rock (ground)	1.50	....	....	0.60	27.43	28.03
S. Carolina rock (floats)	....	....	....	....	....	27.20
S. Carolina rock (dissolved)	....	....	....	11.60	3.60	15.20
II. Potash Manures.						
Carnallite	....	....	13.68	....	....	....
Cotton-seed hull ashes	7.33	....	23.80	....	....	8.50
Kainit	3.20	....	13.54	....	....	....
Krugite	4.82	....	8.42	....	....	....
Muriate of potash	2.00	....	52.46	....	....	....
Nitrate of potash	1.93	13.09	45.19	....	....	....
Spent tan-bark ashes	6.31	....	2.04	....	....	1.61
Sulph. potash (high grade)	1.25	....	38.60	....	....	....
Sulph. potash and magnesia	4.75	....	23.50	....	....	....
Sylvinite	7.25	....	16.65	....	....	....
Waste from gunpowder works	2.75	2.43	18.00	....	....	....
Wood-ashes (unleached)	12.00	....	5.50	....	....	1.85
Wood-ashes (leached)	....	....	1.10	....	....	1.40
III. Nitrogenous Manures.						
Ammoniate	5.88	11.33	....	....	....	3.43
Castro pomace	9.98	5.56	1.12	....	....	2.16
Cotton-seed meal	6.80	6.66	1.62	....	....	1.45
Dried blood	12.50	10.52	....	....	....	1.91
Dried fish	12.75	7.25	0.45	3.05	5.20	8.25
Horn and hoof waste	10.17	13.25	....	....	....	1.83
Lobster shells	7.27	4.50	....	....	....	3.52
Meat scrap	12.09	10.44	....	....	....	2.07

Analyses of Commercial Fertilizing Materials.
Continued.

Name of Substance.	Moisture.	Nitrogen	Potash.	Phosphoric Acid. Available.	Phosphoric Acid. Insoluble.	Phosphoric Acid. Total.
III. Nitrogenous Manures.—Continued.						
Malt sprouts	7.40	4.04	2.20	....	....	1.70
Nitrate of Soda	1.25	15.75	....	....	....	....
Nitre-cake	6.00	2.30	0.40	....	....	....
Oleomargarine refuse	8.54	12.12	....	....	....	0.88
Sulphate of ammonia	1.00	20.50	....	....	....	....
Tankage	13.20	6.82	....	5.02	6.23	11.25
Tobacco stems	10.61	2.29	6.44	....	....	0.60
Wool waste	9.27	5.64	1.30	....	....	0.29
IV. Miscellaneous Materials.						
Ashes (anthracite coal)	....	....	0.10	....	....	0.10
Ashes (bituminous coal)	....	....	0.40	....	....	0.40
Ashes (corn-cob)	....	....	23.20	....	....	....
Ashes (lime-kiln)	15.45	....	0.86	....	....	1.18
Ashes (peat and bog)	5.20	....	0.70	....	....	0.50
Gas lime	4.40	0.30	....	....	....	....
Marls (Maryland)	1.73	....	1.25	....	....	0.38
Marls (Massachusetts)	18.18	....	....	...	....	1.05
Marls (North Carolina)	1.50	....	0.04	....	....	0.56
Marls (Virginia)	15.98	....	0.49	....	....	0.09
Muck (fresh)	76.20	0.30	....	....	....	....
Muck (air-dry)	21.40	1.30	....	....	....	....
Mud (fresh water)	40.37	1.37	0.22	....	....	0.26
Mud (from sea-meadows)	53.50	0.20	0.20	....	....	0.10
Peat	61.50	0.75	....	....	....	....
Pine straw (dead leaves or pine needles)	7.80	0.30	0.10	....	....	0.20
Shells (mollusks)	....	0.10	0.04	....	....	0.03
Shells (crustacea)	....	6.20	0.20	....	....	2.30
Shell lime (oyster shell)	19.50	....	0.04	....	....	0.20
Soot	5.54	....	1.83	....	....	....
Spent tan	14.00	0.20	0.10	....	....	0.04
Spent sumach	30.80	1.00	0.30	....	....	0.10
Sugar-house scum	50.20	2.10	....	....	....	....
Turf	19.29	1.94	....	....	....	....

Pure Dry $(NH_4)_2SO_4$ has 21.21 N—25.76 NH_3.
Pure Dry $NaNO_3$ has 16.47 N — 20.00 NH_3.

Analyses of Farm Manures.

Taken Chiefly from Reports of the New York, Massachusetts and Connecticut Experiment Stations.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
I.				
Cattle (solid fresh excrement)..	....	0.29	0.10	0.17
Cattle (fresh urine)...........	....	0.58	0.49	....
Hen manure (fresh)...........	....	1.63	0.85	1.54
Horse (solid fresh excrement)...	....	0.44	0.35	0.17
Horse (fresh urine)............	....	1.55	1.50	....
Human excrement (solid)......	77.20	1.00	0.25	1.09
Human urine.................	95.90	0.60	0.20	0.17
Poudrette (night soil)..........	....	0.80	0.30	1.40
Sheep (solid fresh excrement)...	....	0.55	0.15	0.31
Sheep (fresh urine)............	....	1.95	2.26	0.01
Stable manure (mixed)........	73.27	0.50	0.60	0.30
Swine (solid fresh excrement)...	....	0.60	0.13	0.41
Swine (fresh urine)............	....	0.43	0.83	0.07

Analyses of Fertilizing Materials in Farm Products.

Analyses of Hay and Dry Coarse Fodders.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
II. Hay and Dry Coarse Fodders.				
Blue melilot..................	8.22	1.92	2.80	0.54
Buttercups...................	....	1.02	0.81	0.41
Carrot tops (dry).............	9.76	3.13	4.88	0.61
Clover (alsike)...............	9.93	2.33	2.01	0.70
Clover (Bokhara).............	6.36	1.77	1.67	0.44
Clover (mammoth red)........	11.41	2.23	1.22	0.55
Clover (medium red)..........	10.72	2.09	2.20	0.44
Clover (white)................	....	2.75	1.81	0.52
Corn fodder..................	....	1.80	0.76	0.51
Corn stover..................	28.24	1.12	1.32	0.30
Cow-pea vines................	9.00	1.64	0.91	0.53
Daisy (white)................	9.65	0.28	1.25	0.44
Daisy (ox-eye)...............	....	0.80	2.23	0.27
Hungarian grass..............	7.15	1.16	1.28	0.35
Italian rye-grass..............	8.29	1.15	0.99	0.55
June grass...................	....	1.05	1.46	0.37
Lucern (alfalfa)	6.26	2.07	1.46	0.53

Analyses of Fertilizing Materials in Farm Products.
Continued.

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
II. Hay and Dry Coarse Fodders—Continued.				
Meadow fescue	9.79	0.94	2.01	0.34
Meadow foxtail	....	1.54	2.19	0.44
Mixed grasses	11.26	1.37	1.54	0.35
Orchard grass	8.84	1.31	1.88	0.41
Perennial rye-grass	9.13	1.23	1.55	0.56
Red-top	7.71	1.15	1.02	0.36
Rowen	12.48	1.75	1.97	0.46
Salt hay	5.36	1.18	0.72	0.25
Serradella	7.39	2.70	0.65	0.78
Soja bean	6.30	2.32	1.08	0.67
Tall meadow oat	....	1.16	1.72	0.32
Timothy hay	7.52	1.26	1.53	0.46
Vetch and oats	11.98	1.37	0.90	0.53
Yellow trefoil	....	2.14	0.98	0.43
III. Green Fodders.				
Buckwheat	82.60	0.51	0.43	0.11
Clover (red)	80.00	0.53	0.46	0.13
Clover (white)	81.00	0.56	0.24	0.20
Corn fodder	72.64	0.56	0.62	0.28
Corn fodder (ensilage)	71.60	0.36	0.33	0.14
Cow-pea vines	78.81	0.27	0.31	0.98
Horse bean	74.71	0.68	1.37	0.33
Lucern (alfalfa)	75.30	0.72	0.45	0.15
Meadow grass (in flower)	70.00	0.44	0.60	0.15
Millet	62.58	0.61	0.41	0.19
Oats (green)	83.36	0.49	0.38	0.13
Peas	81.50	0.50	0.56	0.18
Prickly comfrey	....	0.42	0.75	0.11
Rye grass	70.00	0.57	0.53	0.17
Serradella	82.59	0.41	0.42	0.14
Sorghum	....	0.40	0.32	0.08
Spanish moss	60.80	0.28	0.26	0.30
Vetch and oats	86.11	0.24	0.79	0.09
White lupine	85.35	0.44	1.73	0.35
Young grass	80.00	0.50	1.16	0.22
IV. Straw, Chaff, Leaves, etc.				
Barley chaff	13.08	1.01	0.99	0.27
Barely straw	13.25	0.72	1.16	0.15
Bean shells	18.50	1.48	1.38	0.55

Analyses of Fertilizing Materials in Farm Products. *Continued.*

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
IV. Straw, Chaff, Leaves, etc. Continued.				
Beech leaves (autumn)........	15.00	0.80	0.30	0.24
Buckwheat straw..............	16.00	1.30	2.41	0.61
Cabbage leaves (air-dried).....	14.60	0.24	1.71	0.75
Cabbage stalks (air-dried).....	16.80	0.18	3.49	1.06
Carrots (stalks and leaves).....	80.80	0.51	0.37	0.21
Corn cobs...................	12.09	0.50	0.60	0.06
Corn hulls..................	11.50	0.23	0.24	0.02
Hops.......................	11.07	2.53	1.99	1.75
Oak leaves	15.00	0.80	0.15	0.34
Oat chaff...................	14.30	0.64	1.04	0.20
Oat straw...................	28.70	0.29	0.88	0.11
Pea shells..................	16.65	1.36	1.38	0.55
Pea straw (cut in bloom)......	....	2.29	2.32	0.68
Pea straw (ripe).............	....	1.04	1.01	0.35
Potato stalks and leaves.......	77.00	0.49	0.07	0.06
Rye straw..................	15.40	0.24	0.76	0.19
Sugar-beet stalks and leaves....	92.65	0.35	0.16	0.07
Turnip stalks and leaves.......	89.80	0.30	0.24	0.13
Wheat chaff (spring)..........	14.80	0.91	0.42	0.25
Wheat chaff (winter)..........	10.56	1.01	0.14	0.19
Wheat straw (spring)..........	15.00	0.54	0.44	0.18
Wheat straw (winter)..........	10.36	0.82	0.32	0.11
V. Roots, Tubers, etc.				
Beets (red).................	87.73	0.24	0.44	0.09
Beets (sugar)................	84.65	0.25	0.29	0.08
Beets (yellow fodder)..........	90.60	0.19	0.46	0.09
Carrots.....................	90.02	0.14	0.54	0.10
Mangolds...................	87.29	0.19	0.38	0.09
Potatoes	79.75	0.21	0.29	0.07
Ruta bagas..................	87.82	0.21	0.50	0.13
Turnips.....................	87.20	0.22	0.41	0.12
VI. Grains and Seeds.				
Barley......................	15.42	2.06	0.73	0.95
Beans......................	....	4.10	1.20	1.16
Buckwheat..................	14.10	1.44	0.21	0.44
Corn kernels................	10.88	1.82	0.40	0.70
Corn kernels and cobs (cob meal)	10.00	1.46	0.44	0.60
Hemp seed..................	12.20	2.62	0.97	1.75
Linseed.....................	11.80	3.20	1.04	1.30
Lupines.....................	13.80	5.52	1.14	0.87

Analyses of Fertilizing Materials in Farm Products.
Continued.

Name of Substance.	Moisture	Nitrogen.	Potash.	Phosphoric Acid.
VI. Grains and Seeds.—Continued.				
Millet........................	13.00	2.40	0.47	0.91
Oats........................	20.80	1.75	0.41	0.48
Peas........................	19.10	4.26	1.23	1.26
Rye........................	14.90	1.76	0.54	0.82
Soja beans..................	18.83	5.30	1.99	1.87
Sorghum....................	14.00	1.48	0.42	0.81
Wheat (spring)...............	14.75	2.36	0.61	0.89
Wheat (winter)...............	15.40	2.83	0.50	0.68
VII. Flour and Meal.				
Corn meal....................	13.52	2.05	0.44	0.71
Ground barley...............	13.43	1.55	0.34	0.66
Hominy feed.................	8.93	1.63	0.49	0.98
Pea meal....................	8.85	3.08	0.99	0.82
Rye flour....................	14.20	1.68	0.65	0.85
Wheat flour..................	9.83	2.21	0.54	0.57
VIII. By-products and Refuse..				
Apple pomace................	80.50	0.23	0.13	0.02
Cotton hulls..................	10.63	0.75	1.08	0.18
Cotton-seed meal.............	....	6.52	1.89	2.78
Glucose refuse...............	8.10	2.62	0.15	0.29
Gluten meal..................	8.53	5.43	0.05	0.43
Hop refuse...................	8.98	0.98	0.11	0.20
Linseed cake (new process)....	6.12	5.40	1.16	1.42
Linseed cake (old process).....	7.79	6.02	1.16	1.65
Malt sprouts.................	10.28	3.67	1.60	1.40
Oat bran....................	8.19	2.25	0.66	1.11
Rye middlings................	12.54	1.84	0.81	1.26
Spent brewer's grains (dry)....	6.98	3.05	1.55	1.26
Spent brewer's grains (wet)....	75.01	0.89	0.05	0.31
Wheat bran..................	11.01	2.88	1.62	2.87
Wheat middlings.............	9.18	2.63	0.63	0.95
IX. Dairy Products.				
Milk........................	87.20	0.58	0.17	0.30
Cream.......................	68.80	0.58	0.09	0.15
Skim-milk...................	90.20	0.58	0.19	0.34
Butter......................	13.60	0.12	....	....
Butter-milk..................	90.10	0.64	0.09	0.15
Cheese (from unskimmed milk).	38.00	4.05	0.29	0.80
Cheese(from half-skimmed milk)	39.80	4.75	0.29	0.80
Cheese (from skimmed milk)...	46.00	5.45	0.20	0.80

Analyses of Fertilizing Materials in Farm Products. *Continued.*

Name of Substance.	Moisture.	Nitrogen.	Potash.	Phosphoric Acid.
X. Flesh of Farm Animals.				
Beef	77.00	3.60	0.52	0.43
Calf (whole animal)	66.20	2.50	0.24	1.38
Ox	59.70	2.66	0.17	1.86
Pig	52.80	2.00	0.90	0.44
Sheep	59.10	2.24	0.15	1.23
XI. Garden Products.				
Asparagus	....	0.32	0.12	0.09
Cabbage	....	0.30	0.43	0.11
Cucumbers	....	0.16	0.24	0.12
Lettuce	....	0.20	0.25	0.11
Onions	....	0.27	0.25	0.13

Table Showing the Number of Pounds of Nitrogen, Phosphoric Acid, and Potash Withdrawn Per Acre by an Average Crop.

(From New York, New Jersey and Connecticut Experiment Stations' Reports.)

Name of Crop.	Nitrogen.	Phosphoric Acid.	Potash.
Barley	78	35	62
Buckwheat	63	40	17
Cabbage (white)	213	125	514
Cauliflower	202	76	265
Cattle turnips	187	74	426
Carrots	166	65	190
Clover, green (trifolium pratense)	171	46	154
Clover (trifolium pratense)	37	18	29
Clover, scarlet (trifolium incarnatum)	95	17	57
Clover (trifolium repens)	89	29	58
Cow pea	254	64	169
Corn	146	69	174
Corn fodder (green)	122	66	236
Cotton	110	32	35
Cucumbers	142	94	193
Esparsette	239	36	103
Hops	200	54	127
Hemp	...	34	54
Lettuce	41	17	72
Lucern	289	65	181
Lupine, green (for fodder)	219	46	63
Lupine, yellow (lupinus luteus)	80	37	155
Meadow hay	166	53	201

Table Showing the Number of Pounds of Nitrogen, Phosphoric Acid, and Potash Withdrawn Per Acre by an Average Crop.

Continued.

Name of Crop.	Nitrogen.	Phosphoric Acid.	Potash.
Oats	89	35	96
Onions	96	49	96
Peas (pisuni sativum)	153	39	69
Poppy	87	30	87
Potatoes	119	55	192
Rape	154	79	124
Rice	39	24	45
Rye	87	44	76
Seradella	128	57	196
Soja bean	297	62	87
Sugar cane	518	37	107
Sorghum (sorghum saccharatum)	446	90	561
Sugar beet (beet-root)	95	44	200
Tobacco	127	32	148
Vetch (visia sativa)	149	35	113
Wheat	111	45	58

Fertilizer Experiments on Meadow Land.

(Kentucky Agricultural Experiment Station Bulletin, No. 23, February, 1890.)

On low and decidedly wet land:

English Blue Grass.

Fertilizers Used Per Acre.	Amount Per Acre in Pounds.	Yield of Hay in Pounds Per Acre.
Sulphate of potash	160	3,000
Muriate of potash	160	2,950
Nitrate of Soda	160	3,100
Sulphate of ammonia	130	3,600
No fertilizer	...	2,850
Stable manure	20 loads.	2,970
Tobacco stems	4,000	4,700

Fertilizer Experiments on Meadow Land.—*Continued.*

TIMOTHY.

Kind of Fertilizer Used.	Amount Per Acre in Pounds.	Yield of Hay in Pounds Per Acre.
Sulphate of potash	160	1,900
Muriate of potash	160	2,320
Nitrate of Soda	160	2,670
Sulphate of ammonia	130	2,520
No fertilizer	...	1,620
Stable manure	20 loads.	2,200
Tobacco stems	4,000	3,350

Time Required for the Complete Exhaustion of Available Fertilizing Materials and the Amounts of Each Remaining in the Soil During a Period of Seven Years.

(FROM SCOTTISH ESTIMATES.)

ON UNCULTIVATED CLAY LOAM.

Kind of Fertilizer.	Exhausted (in years).	Per cent. remaining in the soil unexhausted at the end of each year. 1	2	3	4	5	6	7
Lime	12	80	65	55	45	35	25	20
Bone meal	5	60	30	20	10	00	00	00
Phosphatic guanos	5	50	30	20	10	00	00	00
Dissolved bones and plain superphosphates	4	20	10	5	00	00	00	00
High grade ammoniated fertilizers, guano, etc	3	30	20	00	00	00	00	00
Cotton-seed meal	5	40	30	20	10	00	00	00
Barn-yard manure	5	60	30	20	10	00	00	00

ON UNCULTIVATED LIGHT OR MEDIUM SOILS.

Kind of Fertilizer.	Exhausted (in years).	1	2	3	4	5	6	7
Lime	10	75	60	40	30	20	15	
Bone meal	4	60	30	10	00	00	00	
Phosphatic guanos	4	50	20	10	00	00	00	
Dissolved bones and plain super-phosphates	3	20	10	5	00	00	00	00
High grade ammoniates, guanos	3	30	20	00	00	00	00	00
Cotton-seed meal	4	40	30	20	10	00	00	00
Barn-yard manure	4	60	30	10	00	00	00	00

ON UNCULTIVATED PASTURE LAND.

Kind of Fertilizer.	Exhausted (in years).	1	2	3	4	5	6	7
Lime	15	80	70	60	50	45	40	35
Bone meal	7	60	50	40	30	20	10	00
Phosphatic guano	6	50	40	30	20	10	00	80
Dissolved bone, etc	4	30	20	10	00	00	00	00
High grade ammoniated guanos	4	30	20	10	00	00	00	00
Cotton-seed meal	5	40	30	20	10	00	00	00
Barn-yard manure	7	60	50	40	30	20	10	00

Food for Plants
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Sulphate of ammonia, Nitrate of Soda, sulphate, Nitrate and muriate of potash are generally held to be entirely exhausted by the crops grown the season of their application.

The figures given above are always used in fixing the price for new tenants. In this country no such careful estimates have been made, but the proportions probably vary but little from those in other countries.

Amounts of Nitrogen, Phosphoric Acid, and Potash Found Profitable for Different Crops Under Average Conditions Per Acre.

(Taken Chiefly from New Jersey Experiment Station's Reports.)

	Nitrogen, Pounds.	Phosphoric Acid, Pounds.	Potash, Pounds.
Wheat, rye, oats, corn	16	40	30
Potatoes and root crops	20	25	40
Clover, beans, peas and other leguminous crops	40	40	60
Fruit trees and small fruits	25	40	75
General garden produce	30	40	60

The Various Potash Salts and Their Composition.

	Sulphate Potash.	Chloride Potash.	Sulphate Magnesia	Chloride Magnesia.	Chloride Sodium (Common Salt).	Sulphate Lime (Gypsum).	Insoluble in Water.	Water.	Potash.	Salts Neutralizing Ammonia.
A. Natural Products of the Mines.										
Kainit	21.3	2.0	14.5	12.4	34.6	1.7	0.8	12.7	12.8	28.6
Carnallite	....	15.5	12.1	21.5	22.4	1.9	0 5	26.1	9.8	35.5
Kieserite	....	11.8	21.5	17.2	26.7	0.8	1.3	20.7	7.5	39.5
Sylvinite *a*	7.1	24.7	5.8	4.0	46.2	1 9	1.9	8.4	19.4	11.7
Sylvinite *b*	17.2	11.1	11.8	8.1	38.2	3.6	0.3	9.7	16.3	23.5
Sylvinite *c*	16.3	14.0	11.8	9.3	34.9	3.6	1.8	8.3	17.6	24.7
B. Concentrated Products.										
a. Sulphates of Potash.										
1. Sulphate of potash, high-graded, 96%	97.2	0.3	0.7	0.4	0.2	0.3	0.2	0.7	52.7	
2. Sulphate of potash, high-graded, 90%	90.6	1.6	2.7	1.0	1.2	0.4	0 3	2.2	49.9	
3. Double sulphate of potash and sulphate of magnesia (double manure salt)	50.4	...	34.0	....	2.5	0.9	0.6	11.6	27.2	34.9
4. Calcined kieserite	....	....	65.8	....	0.9	6.5	15.7	11.1	....	72.3
b. Muriates of Potash.										
Muriate of potash 90-95%	....	91.7	0.2	0.2	7.1	....	0.2	0.6	57.9	
Muriate of potash 80-85%	....	83.5	0.4	0.3	14.5	....	0.2	1.1	52.7	
Muriate of potash 70-75%	1.7	72.5	0.8	0.6	21.0	0.2	0.5	2.5	46.7	
Calcined manure salt, high grade	....	44 5	22.5	4.6	12.4	2.9	5.3	7.8	28.1	30.0
Calcined manure salt, low grade	....	25.6	31.1	6.3	10.3	3 5	10.6	12.6	16.2	40.6

Rotation on Crops.

In the changed conditions of agriculture elaborate systems of crop rotation are no longer necessary. With the help of chemical manures and the judicious use of renovating crops farmers are no longer subject to rigid rule, but may adapt rotations to the varying demands of local market conditions.

Some American Rotations.

1. Potatoes.
2. Wheat.
3. Clover.
4. Clover.
5. Wheat, oats or rye.

1. Potatoes.
2. Wheat.
3. Grass, timothy and clover.
4. Grass, timothy and clover.
5. Corn.

1. Roots.
2. Wheat.
3. Clover.
4. Clover.
5. Corn, oats or rye.

1. Roots.
2. Wheat.
3. Clover.
4. Clover.
5. Wheat.
6. Oats.

Of General Interest.

How to Copyright a Book, Map, Chart, Etc.

Every applicant for a copyright must state distinctly the name and residence of the claimant, and whether the right is claimed as author, designer or proprietor. No affidavit or formal application is required. A printed copy of the title of the book, map, chart, dramatic or musical composition, engraving, cut, print, or photograph, or a description of the painting, drawing, chromo, statue, statuary, or model or design for a work of fine arts, for which copyright is desired, must be sent by mail or otherwise, prepaid, addressed "Librarian of Congress, Washington, D. C." This must be done before publication of the book or other article. A fee of 50 cents, for recording the title of each book or other article, must be inclosed with the title as above, and 50 cents in addition (or one dollar in all) for each certificate of copyright under seal of the Librarian of Congress, which will be transmitted by return mail. Within ten days after publication of each book or other article, two complete copies must be sent prepaid, to perfect the copyright, with the address, "Librarian of Congress, Washington, D. C." Without the deposit of copies above required, the copyright is void, and a penalty of $25 is incurred. No copyright is valid unless notice is given by inserting in every copy published, "Entered according to act of Congress, in the year ——, by ——, in the office of the Librarian of Congress, at Washington";

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Centenarians.

The most remarkable were: The Countess of Desmond, killed by falling from a cherry-tree, in her 146th year.

Thomas Parr, died after a dinner party, in his 152d year.

Cardinal de Salis, who recommended daily exercise in all weathers, aged 110 years.

John Riva, of Venice, who chewed citron bark daily, died at the age of 116 years, leaving a son of 14 years.

Besides the foregoing, Mrs. Ann Butler died at Portsmouth, England, January, 1883, at the age of 103 years.

Mrs. Betty Lloyd died at Ruabon, Wales, in March, 1883, in her 107th year, her funeral being attended by two of her children, aged over 80 years.

What Machinery Accomplishes.

1. A sewing-machine does the work of 12 women. The United States export 100,000 of these machines yearly.

2. A Boston "bootmaker" will enable a workman to make 300 pairs of boots daily. In 1880 there were 3,100 of these machines in various countries, turning out 150 million pairs of boots yearly.

3. Glenn's California reaper will cut, thresh, winnow and put in bags the wheat of 60 acres in 24 hours.

4. The Hercules ditcher, Michigan, removes 750 cubic yards, or 700 tons of clay per hour.

5. The Darlington borer enables one man to do the work of seven in making a tunnel, and reduces the cost to one-third of work done by hand; it also permits a week's work to be done in two days.

Average Annual Rainfall in the United States.

Place.	Inches.	Place.	Inches.
Neah Bay, Wash.	123	Hanover, New Hampshire	40
Sitka, Alaska	83	Ft. Vancouver	38
Ft. Haskins, Oregon	66	Cleveland, Ohio	37
Mt. Vernon, Alabama	66	Pittsburgh, Pennsylvania	37
Baton Rouge, Louisiana	60	Washington, D. C.	37
Meadow Valley, California	57	White Sulphur Springs, Va	37
Ft. Tonson, Indian Ter.	57	Ft. Gibson, Indian Territory	36
Ft. Myers, Florida	56	Key West, Florida	36
Washington, Arkansas	54	Peoria, Illinois	35
Huntsville, Alabama	54	Burlington, Vermont	34
Natchez, Mississippi	53	Buffalo, New York	33
New Orleans, Louisiana	51	Ft. Brown, Texas	33
Savannah, Georgia	48	Ft. Leavenworth, Kansas	31
Springdale, Kentucky	48	Detroit, Michigan	30
Fortress Monroe, Virginia	47	Milwaukee, Wisconsin	30
Memphis, Tennessee	45	Penn Yan, New York	28
Newark, New Jersey	44	Ft. Kearney	25
Boston, Massachusetts	44	Ft. Snelling, Minnesota	25
Brunswick, Maine	44	Salt Lake City, Utah	23
Cincinnati, Ohio	44	Mackinac, Michigan	23
New Haven, Connecticut	44	San Francisco, California	21
Philadelphia, Pennsylvania	44	Dallas, Oregon	21
Charleston, South Carolina	43	Sacramento, California	21
New York City, N. Y.	43	Ft. Massachusetts, Colorado	17
Gaston, North Carolina	43	Ft. Marcy, New Mexico Ter.	16
Richmond, Indiana	43	Ft. Randall, Dakota	16
Marietta, Ohio	43	Ft. Defiance, Arizona	14
St. Louis, Missouri	43	Ft. Craig, New Mexico Ter.	11
Muscatine, Iowa	42	San Diego, California	9
Baltimore, Maryland	41	Ft. Colville, Washington	9
New Bedford, Massachusetts	41	Ft. Bliss, Texas	9
Providence, Rhode Island	41	Ft. Bridger, Utah	6
Ft. Smith, Arkansas	40	Ft. Garland, Colorado	6

Number of Years Seeds Retain Their Vitality.

Vegetables.	Years.	Vegetables.	Years.
Cucumber	8 to 10	Asparagus	2 to 3
Melon	8 to 10	Beans	2 to 3
Pumpkin	8 to 10	Carrots	2 to 3
Squash	8 to 10	Celery	2 to 3
Broccoli	5 to 6	Corn (on cob)	2 to 3
Cauliflower	5 to 6	Leek	2 to 3
Artichoke	5 to 6	Onion	2 to 3
Endive	5 to 6	Parsley	2 to 3
Pea	5 to 6	Parsnip	2 to 3
Radish	4 to 5	Pepper	2 to 3
Beets	3 to 4	Tomato	2 to 3
Cress	3 to 4	Egg-Plant	1 to 2
Lettuce	3 to 4		
Mustard	3 to 4	HERBS.	
Okra	3 to 4	Anise	3 to 4
Rhubarb	3 to 4	Caraway	2
Spinach	3 to 4	Summer Savory	1 to 2
Turnip	3 to 6	Sage	2 to 3

How Deep in the Ground to Plant Corn.

The following is the result of an experiment with Indian Corn. That which was planted at the depth of

1 inch, came up in	8½ days.
1½ inch, came up in..........................	9½ days.
2 inches, came up in.........................	10 days.
2½ inches, came up in........................	11½ days.
3 inches, came up in.........................	12 days.
3½ inches, came up in........................	13 days.
4 inches, came up in.........................	13½ days.

The more shallow the seed was covered with earth, the more rapidly the sprout made its appearance, and the stronger afterwards was the stalk. The deeper the seed lay, the longer it remained before it came to the surface. Four inches was too deep for the maize, and must, therefore, be too deep for smaller kernels.

Amount of Barbed Wire Required for Fences.

Estimated number of pounds of Barbed Wire required to fence space or distances mentioned, with one, two or three lines of wire, based upon each pound of wire measuring one rod (16½ feet).

	1 Line.	2 Lines.	3 Lines.
1 square acre...........	50⅔ lbs.	101⅓ lbs.	152 lbs.
1 side of a square acre...	12⅔ lbs.	25⅓ lbs.	38 lbs.
1 square half-acre	36 lbs.	72 lbs.	108 lbs.
1 square mile	1280 lbs.	2560 lbs.	3840 lbs.
1 side of a square mile..	230 lbs.	640 lbs.	960 lbs.
1 rod in length.........	1 lb.	2 lbs.	3 lbs.
100 rods in length......	100 lbs.	200 lbs.	300 lbs.
100 feet in length.......	6 1/16 lbs.	12⅛ lbs.	18 3/16 lbs.

How Grain will Shrik.

Farmers rarely gain by holding on to their grain after it is fit for market, when the shrinkage is taken into account. Wheat, from the time it is threshed, will shrink two quarts to the bushel or six per cent. in six months, in the most favorable circumstances. Hence, it follows that ninety-four cents a bushel for wheat when first threshed in August, is as good, taking into account the shrinkage alone, as one dollar in the following February.

Corn shrinks much more from the time it is first husked. One hundred bushels of ears, as they come from the field in November, will be reduced to not far from eighty. So that forty cents a bushel for corn in the ear, as it comes from the field, is as good as fifty in March, shrinkage only being taken into account.

In the case of potatoes—taking those that rot and are otherwise lost—together with the shrinkage, there is but little doubt that between October and June, the loss to the owner who holds them is not less than thirty-three per cent.

This estimate is taken on the basis of interest at 7 per cent., and takes no account of loss by vermin.

One hundred pounds of Indian meal is equal to 76 pounds of wheat, 83 of oats, 90 of rye, 111 of barley, 333 of corn stalks.

Length of Navigation of the Mississippi River.

The length of navigation of the Mississippi River itself for ordinary large steamboats is about 2,161 miles, but small steamers can ascend about 650 miles further. The following are its principal navigable tributaries, with the miles open to navigation:

	Miles.		Miles.
Minnesota	295	Wisconsin	160
Chippewa	90	Rock	64
Iowa	80	Illinois	350
Missouri	2900	Yellowstone	474
Big Horn	50	Ohio	950
Allegheny	325	Monongahela	110
Muskingum	94	Kanawha	94
Kentucky	105	Green	200
Wabash	365	Cumberland	600
Tennessee	270	Clinch	50
Osage	302	St. Francis	180
White	779	Black	147
Little White	48	Arkansas	884
Big Hatchie	75	Issaquena	161
Sunflower	271	Yazoo	228
Tallahatchie	175	Big Black	35
Red	986	Cane	54
Cypress	44	Ouachita	384
Black	61	Bœuf	55
Bartholomew	100	Tensas	112
Macon	60	Teche	91
Atchafalaya	218	D'Arbonne	50
Lafourche	168		

The other ten navigable tributaries have less than fifty miles each of navigation. The total miles of navigation of these fifty-five streams is about 16,500 miles, or about two-thirds the distance around the world. The Mississippi and its tributaries may be estimated to possess 15,550 miles navigable to steamboats, and 20,221 miles navigable to barges.

How to Measure Corn in Crib, Hay in Mow, Etc.

This rule will apply to a crib of any size or kind. Two cubic feet of good, sound, dry corn in the ear will make a bushel of shelled corn. To get, then, the quantity of shelled corn in a crib of corn in the ear, measure the length, breadth and height of the crib, inside of the rail; multiply the length by the breadth and the product by the height; then divide the product by two, and you have the number of bushels of shelled corn in the crib.

To find the number of bushels of apples, potatoes, etc., in a bin, multiply the length, breadth and thickness together, and this product by 8, and point off one figure in the product for decimals.

To find the amount of hay in a mow, allow 512 cubic feet for a ton, and it will come out very generally correct.

The Great Canals of the World.

The Imperial canal of China is over 1,000 miles long. In the year of 1861 was completed the greatest undertaking of the kind on the European continent, the canal of Languedoc, or the Canal du Midi, to connect the Atlantic

with the Mediterranean; its length is 148 miles, it has more than 100 locks, and about 50 aqueducts, and its highest part is no less than 600 feet above the sea; it is navigable for vessels of upward of 100 tons. The largest ship canal in Europe is the great North Holland canal, completed in 1825—125 feet wide at the water surface, 31 feet wide at the bottom, and has a depth of 20 feet; it extends from Amsterdam to the Helder, 51 miles. The Caledonia canal, in Scotland, has a total length of 60 miles, including 3 lakes. The Suez canal is 88 miles long, of which 66 miles are actual canal. The Erie canal is 350½ miles long; the Ohio canal, Cleveland to Portsmouth, 332; the Miami and Erie, Cincinnati to Toledo, 291; the Wabash and Erie, Evansville to the Ohio line, 374.

Carrying Capacity of a Freight Car.

THIS TABLE IS FOR TEN TON CARS.

Whiskey	60 barrels.	Lumber	6,000 feet.
Salt	70 "	Barley	300 bushels.
Lime	70 "	Wheat	340 "
Flour	90 "	Flax Seed	360 "
Eggs	130 to 160 "	Apples	370 "
Flour	200 sacks.	Corn	400 "
Wood	6 cords.	Potatoes	430 "
Cattle	18 to 20 head.	Oats	680 "
Hogs	50 to 60 "	Bran	1,000 "
Sheep	80 to 100 "	Butter	20,000 pounds.

Rules for Business Farmers.

The way to get credit is to be punctual in paying your bills. The way to preserve it is not to use it much. Settle often; have short accounts.

Trust no man's appearances—they are deceptive—perhaps assumed, for the purpose of obtaining credit. Beware of gaudy exterior. Rogues usually dress well. The rich are plain men. Trust him, if any, who carries but little on his back. Never trust him who flies into a passion on being dunned; make him pay quickly, if there be any virtue in the law.

Be well satisfied before you give a credit that those to whom you give it are safe men to be trusted.

Sell your goods at a small advance, and never misrepresent them, for those whom you once deceive will be aware of you the second time.

Deal uprightly with all men, and they will repose confidence in you, and soon become your permanent customers.

Beware of him who is an office seeker. Men do not usually want an office when they have anything to do. A man's affairs are rather low when he seeks office for support.

Trust no stranger. Your goods are better than doubtful charges. What is character worth, if you make it cheap by crediting everybody?

Agree beforehand with every man about to do a job, and, if large, put it into writing. If any decline this, quit, or be cheated. Though you want a job ever so much, make all sure at the onset, and in a case at all doubtful, make sure of a guarantee. Be not afraid to ask it; the best test of responsibility; for, if offence be taken, you have escaped a loss.

Business Laws in Brief.

Ignorance of law excuses none.

It is a fraud to conceal a fraud.

The law compels no one to do impossibilities.

An agreement without consideration is void.

Signatures made with lead-pencil are good in law.

A receipt for money paid is not legally conclusive.

The acts of one partner bind all the others.

Contracts made on Sunday cannot be enforced.

A contract made with a minor is invalid.

A contract made with a lunatic is void.

Contracts for advertising in Sunday newspapers are invalid.

Each individual in a partnership is responsible for the whole amount of the debts of the firm.

Principals are responsible for the acts of their agents.

Agents are responsible to their principals for errors.

A note given by a minor is void.

It is not legally necessary to say on a note "for value received."

A note drawn on Sunday is void.

A note obtained by fraud, or from a person in a state of intoxication, cannot be collected.

If a note be lost or stolen, it does not release the maker; he must pay.

The indorser of a note is exempt from liability if not served with notice of its dishonor within twenty-four hours of its non-payment.

How to Treat Sunstroke.

Take the patient at once to a cool and shady place, but don't carry him far to a house or hospital. Loosen the clothes thoroughly about his neck and waist. Lay him down with the head a little raised. Apply wet cloths to the head, and mustard or turpentine to the calves of the legs and the soles of the feet. Give a little weak whiskey and water if he can swallow. Meanwhile, let some one go for the doctor. You cannot safely do more without his advice.

Sunstroke is a sudden prostration due to long exposure to great heat, especially when much fatigued or exhausted. It commonly happens from undue exposure to the sun's rays in summer. It begins with pain in the head, or dizziness, quickly followed by loss of consciousness and complete prostration.

How to Remove the Smell of Paint from a Room.

The smell of paint may be taken away by closing up the room and setting in the centre of it a pan of lighted charcoal, on which have been thrown some juniper berries. Leave this in the room for a day and a night, when the smell of the paint will be gone. This is also effectual in removing the odor of tobacco smoke from the room.

Time Required for Digesting Food.

Food.	How Cooked.	H.M.
Apples, sour, hard	Raw	2.50
Apples, sweet, mellow	Raw	1.30
Bass, striped	Broiled	3.00
Beans, pod	Boiled	2.30
Beans and green corn	Boiled	3.45
Beef	Fried	4.00
Beefsteak	Broiled	3.00
Beef, fresh, lean, dry	Roasted	3.30
Beef, fresh, lean, rare	Roasted	3.00
Beets	Boiled	3.45
Bread, corn	Baked	3.15
Bread, wheat, fresh	Baked	1.30
Cabbage	Raw	2.30
Cabbage, with vinegar	Raw	2.00
Cabbage	Boiled	4.30
Carrot, orange	Boiled	3.13
Catfish	Fried	3.30
Cheese, old, strong	Raw	3.30
Chicken, full grown	Fricasseed	2.45
Codfish, cured dry	Boiled	2.00
Custard	Baked	2.45
Duck, tame	Roasted	4.00
Duck, wild	Roasted	4.30
Eggs, fresh	Raw	2.00
Eggs, fresh	Scrambled	1.30
Eggs, fresh	Roasted	2.15
Eggs, fresh	Soft boiled	3.00
Eggs, fresh	Hard boiled	3.30
Eggs, fresh	Fried	3.30
Fowls, domestic	Roasted	4.00
Hashed meat and vegetables	Warmed	2.30
Lamb, fresh	Broiled	2.30
Milk	Boiled	2.00
Milk	Raw	2.15
Mutton, fresh	Broiled	3.00
Oysters, fresh	Raw	2.55
Oysters, fresh	Roasted	3.15
Oysters, fresh	Stewed	3.30
Parsnips	Boiled	2 30
Pork, steak	Broiled	3.15
Pork, fat and lean	Roasted	5.15
Pork, recently salted	Stewed	3.00
Pork, recently salted	Fried	4.15
Potatoes, Irish	Baked	2.30
Potatoes, Irish	Boiled	3.30
Salmon, salted	Boiled	4.00
Sausages, fresh	Broiled	3.20
Soup, bean	Boiled	3.00
Soup, chicken	Boiled	3.00
Soup, mutton	Boiled	3.30
Soup, beef, vegetables	Boiled	4.00
Trout, salmon, fresh	Boiled	1.30
Turkey, domesticated	Roasted	2.30
Veal, fresh	Boiled	4.00
Veal, fresh	Fried	4.30

Spirits of Turpentine a Valuable Remedy.

This is one of the most valuable articles in a family, and when it has once obtained a foothold in a house, it is really a necessity, and could ill be

dispensed with. Its medicinal qualities are very numerous; for burns it is a quick application and gives immediate relief; for blisters on the hands it is of priceless value, searing down the skin and preventing soreness; for corns on the toes it is useful, and good for rheumatism and sore throats, and it is the quickest remedy for convulsions or fits. Then it is a sure preventive against moths; by just dropping a trifle in the bottom of drawers, chests and cupboards, it will render the garments secure from injury during the summer. It will keep ants and bugs from closets and storerooms by putting a few drops in the corners and upon the shelves; it is sure destruction to bedbugs, and will effectually drive them away from their haunts if thoroughly applied to the joints of the bedstead in the spring cleaning time, and injures neither furniture nor clothing. Its pungent odor is retained for a long time, and no family ought to be entirely out of a supply at any time of the year.

How to Rent a Farm.

In the rental of property, the greater risk is always on the landlord's side. He is putting his property into the possession and care of another, and that other is not infrequently a person of doubtful utility. These rules and cautions may well be observed:

1. Trust to no verbal lease. Let it be in writing, signed and sealed. Its stipulations then become commands and can be enforced. Let it be signed in duplicate, so that each party may have an original.
2. Insert such covenants as to repairs, manner of use and in restraint of waste, as the circumstances call for. As to particular stipulations, examine leases drawn by those who have had long experience in renting farms, and adopt such as meet your case.
3. There should be covenants against assigning and underletting.
4. If the tenant is of doubtful responsibility, make the rent payable in installments. A covenant that the crops shall remain the lessor's till the lessee's contracts with him have been fulfilled, is valid against the lessee's creditors. In the ordinary case of renting farms on shares, the courts will treat the crops as the joint property of lord and tenant, and thus protect the former's rights.
5. Every lease should contain stipulations for forfeiture and re-entry in case of non-payment or breach of any covenants.
6. To prevent a tenant's committing waste, the courts will grant an injunction.
7. Above all, be careful in selecting your tenant. There is more in the man than there is in the bond.

Franklin's Words of Wisdom.

Want of care does us more damage than want of knowledge.

For want of a nail the shoe was lost, and for want of a shoe the horse was lost.

For age and want save while you may, no morning sun lasts all the day.

Experience keeps a dear school, but fools will learn in no other.

Lying rides upon debt's back; it is hard for an empty bag to stand upright.

Creditors have better memories than debtors.

Women and wine, game and deceit, make the wealth small and the want great.

What maintains one vice would bring up two children.

Plough deep while sluggards sleep; and you shall have corn to sell and to keep.

Work to-day, for you know not how much you may be hindered to-morrow.

Fly pleasure and it will follow you. The diligent spinner has a large shift.

Now I have a sheep and a cow, everybody bids me good-morrow.

Keep thy shop, and thy shop will keep thee.

If you would have your business done, go, if not, send.

Who dainties love shall beggars prove. Fools lay out money and buy repentance.

Foolish men make feasts, and wise men eat them.

He that by the plough would thrive, himself must either hold or drive.

The eye of the master will do more work than both his hands.

Silks and satins, scarlet and velvets, put out the kitchen fire.

Always taking out of the meal tub and never putting in, soon comes to the bottom.

Drive thy business, let not that drive thee. Sloth makes all things difficult, industry all easy.

Early to bed and early to rise, makes a man healthy, wealthy and wise.

If you would know the value of money, try to borrow some.

When the well is dry, they know the worth of water.

Not to oversee workmen, is to leave them your purse open.

If you would have a faithful servant, and one that you like, serve yourself.

By diligence and perseverance the mouse ate the cable in two.

Diligence is the mother of good luck; and God gives all things to industry.

Industry needs not wish, and he that lives upon hope will die fasting.

There are no gains without pains; then help hands, for I have no lands.

Buy what thou hast no need of, and ere long thou wilt sell thy necessaries.

At a great pennyworth pause awhile; many are ruined by buying bargains.

Philosophical Facts.

The greatest height at which visible clouds ever exist does not exceed ten miles.

Air is about eight hundred and fifteen times lighter than water.

The pressure of the atmosphere upon every square foot of the earth amounts to two thousand one hundred and sixty pounds. An ordinary sized man, supposing his surface to be fourteen square feet, sustains the enormous pressure of thirty thousand, two hundred and forty pounds.

The barometer falls one-tenth of an inch for every seventy-eight feet of elevation.

The violence of the expansion of water when freezing is sufficient to cleave a globe of copper of such thickness as to require a force of 27,000 pounds, to produce the same effect.

During the conversion of ice into water one hundred and forty degrees of heat are absorbed.

Water, when converted into steam, increases in bulk eighteen hundred times.

In one second of time—in one beat of the pendulum of a clock, light travels two hundred thousand miles. Were a cannon ball shot toward the sun, and were it to maintain full speed, it would be twenty years in reaching it—and yet light travels through this space in seven or eight minutes.

Strange as it may appear, a ball of a ton weight and another of the same material of an ounce weight, falling from any height will reach the ground at the same time.

The heat does not increase as we rise above the earth nearer to the sun but decreases rapidly until, beyond the regions of the atmosphere, in void, it is estimated that the cold is about seventy degrees below zero. The line of perpetual frost at the equator is 15,000 feet altitude; 13,000 feet between the tropics; and 9,000 to 4,000 between the latitudes of forty degrees and forty-nine degrees.

At a depth of forty-five feet under ground, the temperature of the earth is uniform throughout the year.

In summer time, the season of ripening moves northward at the rate of about ten miles a day.

The human ear is so extremely sensitive that it can hear a sound that lasts only the twenty-four thousandth part of a second. Deaf persons have sometimes conversed together through rods of wood held between their teeth, or held to their throat or breast.

The ordinary pressure of the atmosphere on the surface of the earth is two thousand one hundred and sixty-eight pounds to each square foot, or fifteen pounds to each square inch; equal to thirty perpendicular inches of mercury, or thirty-four and a half feet of water.

Sound travels at the rate of one thousand one hundred and forty-two feet per second—about thirteen miles in a minute. So that if we hear a clap of thunder half a minute after the flash, we may calculate that the discharge of electricity is six and a half miles off.

Lightning can be seen by reflection at the distance of two hundred miles.

The explosive force of closely confined gunpowder is six and a half tons to the square inch.

What Housekeepers Should Remember.

That cold rain water and soap will remove machine grease from washable fabrics.

That fish may be scaled much easier by first dipping them into boiling water for a minute.

That fresh meat beginning to sour, will sweeten if placed out of doors in the cool air over-night.

That milk which has changed may be sweetened or rendered fit for use again by stirring in a little soda.

That boiling starch is much improved by the addition of sperm or salt, or both, or a little gum arabic dissolved.

That a tablespoonful of turpentine, boiled with your white clothes, will greatly aid the whitening process.

That kerosene will soften boots and shoes that have been hardened by water, and will render them as pliable as new.

That thoroughly wetting the hair once or twice with a solution of salt and water will keep it from falling out.

That salt fish are quickest and best freshened by soaking in sour milk.

That one teaspoonful of ammonia to a teacup of water applied with a rag, will clean silver or gold jewelry perfectly.

That salt will curdle new milk, hence, in preparing porridge, gravies, etc., salt should not be added until the dish is prepared.

That paint stains that are dry and old may be removed from cotton or woolen goods with chloroform. It is a good plan to first cover the spot with olive oil or butter.

That clear boiling water will remove tea stains; pour the water through the stain and thus prevent its spreading over the fabric.

That charcoal is recommended as an absorber of gases in the milk room where foul gases are present. It should be freshly powdered and kept there continually, especially in hot weather, when unwholesome odors are most liable to infect the milk.

That by applying kerosene with a rag when you are about to put your stoves away for the summer, will prevent them from rusting. Treat your farming implements in the same way before you lay them aside in the fall.

That a teaspoonful of borax put in the last water in which clothes are rinsed, will whiten them surprisingly. Pound the borax so it will dissolve easily. This is especially good to remove the yellow that time gives to white garments that have been laid aside for two or three years.

That a good agency for keeping the air of the cellar sweet and wholesome is whitewash, made of good white lime and water only. The addition of glue or size, or anything of this class, is only a damage, by furnishing organic matter to speedily putrify. The use of lime in whitewash is not simply to give a white color, but it greatly promotes the complete oxidation of effluvia in the cellar air. Any vapors that contain combined nitrogen in the unoxidized form contribute powerfully to the development of disease germs.

How to Preserve Eggs.

To each pailful of water, add two pints of fresh slacked lime and one pint of common salt; mix well. Fill your barrel half full with this fluid, put your eggs down in it any time after June, and they will keep two years, if desired.

Estimating Measures.

A pint of water weighs nearly 1 pound, and is equal to about 27 cubic inches, or a square box 3 inches long, 3 inches wide and 3 inches deep.

A quart of water weighs nearly 2 pounds, and is equal to a square box of about 4 by 4 inches and 3½ inches deep.

A gallon of water weighs from 8 to 10 pounds, according to the size of the gallon, and is equal to a box 6 by 6 inches square and 6, 7 or 7½ inches deep.

A peck is equal to a box 8 by 8 inches square and 8 inches deep.

A bushel almost fills a box 12 by 12 inches square and 24 inches deep, or 2 cubic feet.

A cubic foot of water weighs nearly 64 pounds (more correctly, 62½ pounds), and contains from 7 to 8 gallons, according to the kind of gallons used.

A barrel of water almost fills a box 2 by 2 feet square and 1½ feet deep, or 6 cubic feet.

Petroleum barrels contain 40 gallons, or nearly 5 cubic feet.

Number of Nails and Tacks per Pound.

NAILS. Name	Size	Number Per Lb	TACKS. Name.	Length.	Number Per Lb.
3 penny, fine	1⅛ inch	760 nails	1 oz.	⅛ inch	16,000
3 "	1¼ "	480 "	1½ "	3/16 "	10,666
4 "	1½ "	300 "	2 "	¼ "	8,000
5 "	1¾ "	200 "	2½ "	5/16 "	6,400
6 "	2 "	160 "	3 "	⅜ "	5,333
7 "	2¼ "	128 "	4 "	7/16 "	4,000
8 "	2½ "	92 "	6 "	9/16 "	2,666
9 "	2¾ "	72 "	8 "	⅝ "	2,000
10 "	3 "	60 "	10 "	11/16 "	1,600
12 "	3¼ "	44 "	12 "	¾ "	1,333
16 "	3½ "	32 "	14 "	13/16 "	1,143
20 "	4 "	24 "	16 "	⅞ "	1,000
30 "	4¼ "	18 "	18 "	15/16 "	888
40 "	5 "	14 "	20 "	1 "	800
50 "	5½ "	12 "	22 "	1 1/16 "	727
6 " fence	2 "	80 "	24 "	1⅛ "	666
8 " "	2½ "	50 "			
10 " "	3 "	34 "			
12 " "	3¼ "	29 "			

The Longest and Greatest Rivers in the World.

Name.	Miles.	Name.	Miles.
Amazon	3,600	Red River	1,200
Nile	3,000	Colorado in California	1,100
Missouri, to its junction with the Mississippi	2,900	Yellowstone	1,000
Missouri, to the sea, forming the longest in the world	4,100	Ohio	950
Mississippi, proper	2,800	Rhine	950
Lena	2,600	Kansas	900
Niger, or Jobila	2,600	Tennessee	800
Obe	2,500	Red River of the North	700
St. Lawrence	2,200	Cumberland	600
Madeira	2,000	Alabama	600
Arkansas	2,000	Susquehanna	500
Volga	2,000	Potomac	500
Rio Grande	1,800	James	500
Danube	1,600	Connecticut	450
St. Francisco	1,300	Delaware	400
Columbia	1,200	Hudson	350
Nebraska	1,200	Kennebec	300
		Thames	233

Number Brick Required to Construct any Building.

(Reckoning 7 Brick to Each Superficial Foot.)

Superficial Feet of Wall.	Number of Bricks to Thickness of					
	4 inch.	8 inch.	12 inch	16 inch	20 inch.	24 inch.
1	7	15	23	30	38	45
2	15	30	45	60	75	90
3	23	45	68	90	113	135
4	30	60	90	120	150	180
5	38	75	113	150	188	225
6	45	90	135	180	225	270
7	53	105	158	210	263	315
8	60	120	180	240	300	360
9	68	135	203	270	338	405
10	75	150	225	300	375	450
20	150	300	450	600	750	900
30	225	450	675	900	1,125	1,350
40	300	600	900	1.200	1,500	1,800
50	375	750	1,125	1,500	1,875	2,250
60	450	900	1.350	1,800	2,250	2,700
70	525	1,050	1,575	2,100	2,625	3,150
80	600	1,200	1,800	2,400	3,000	3,600
90	675	1,350	2,025	2,700	3.375	4,050
100	750	1,500	2 250	3,000	3,750	4,500
200	1,500	3,000	4,500	6,000	7,500	9 000
300	2,250	4.500	6 750	9.000	11,250	13.500
400	3,000	6,000	9,000	12,000	15,000	18,000
500	3,750	7,500	11,250	15,000	18,750	22,500
600	4,500	9,000	13.500	18,000	22,500	27,000
700	5.250	10,500	15,750	21,000	26,250	31,500
800	6,000	12,000	18,000	24,000	30,000	36,000
900	6,750	13,500	20,250	27,000	33,750	40,500
1000	7.500	15,000	22,500	30,000	37,500	45,000

Facts for Builders.

One thousand shingles, laid 4 inches to the weather, will cover 100 square feet of surface, and 5 pounds of shingle nails will fasten them on.

One-fifth more siding and flooring is needed than the number of square feet of surface to be covered, because of the lap in the siding and matching.

One thousand laths will cover 70 yards of surface, and 11 pounds of lath nails will nail them on. Eight bushels of good lime, 16 bushels of sand, and one bushel of hair, will make enough good mortar to plaster 100 square yards.

A cord of stone, 3 bushels of lime and a cubic yard of sand, will lay 100 cubic feet of wall.

Five courses of brick will lay one foot in height on a chimney; 16 bricks in a course will make a flue 4 inches wide and 12 inches long, and 8 bricks in a course will make a flue 8 inches wide and 16 inches long.

Cement 1 bushel and sand 2 bushels will cover $3\frac{1}{2}$ square yards one inch thick, $4\frac{1}{2}$ square yards $\frac{3}{4}$ inch thick, and $6\frac{3}{4}$ square yards $\frac{1}{2}$ inch thick. One bush. cement and 1 of sand will cover $2\frac{1}{4}$ square yards 1 inch thick, 3 square yards $\frac{3}{4}$ inch thick, and $4\frac{1}{2}$ square yards, $\frac{1}{2}$ inch thick.

Weight of a Cubic Foot of Earth, Stone, Metal, Etc.

Article.	Pounds.	Article.	Pounds.
Alcohol	49	Milk	64
Ash wood	53	Maple	47
Bay wood	51	Mortar	110
Brass, gun metal	543	Mud	102
Blood	66	Marble, Vermont	165
Brick, common	102	Mahogany	66
Cork	15	Oak, Canadian	54
Cedar	35	Oak, live, seasoned	67
Copper, cast	547	Oak, white, dry	54
Clay	120	Oil, linseed	59
Coal, Lehigh	56	Pine, yellow	34
Coal, Lackawanna	50	Pine, white	34
Cider	64	Pine, red	37
Chestnut	38	Pine, well seasoned	30
Earth, loose	94	Silver	625¾
Glass, window	165	Steel, plates	487¾
Gold	1,203⅔	Steel, soft	489
Hickory, shell bark	43	Stone, common, about	158
Hay, bale	9	Sand, wet, about	128
Hay, pressed	25	Spruce	31
Honey	90	Tin	455
Iron, cast	450	Tar	63
Iron, plates	481	Vinegar	67
Iron, wrought bars	486	Water, salt	64
Ice	57½	Water, rain	62
Lignum Vitæ wood	83	Willow	36
Logwood	57	Zinc, cast	428
Lead, cast	709		

What a Deed to a Farm in Many States Includes.

Every one knows it conveys all the fences standing on the farm, but all might not think it also included the fencing-stuff, posts, rails, etc., which had once been used in the fence, but had been taken down and piled up for future use again in the same place. But new fencing material, just bought, and never attached to the soil, would not pass. So piles of hop poles stored away, if once used on the land and intended to be again so used, have been considered a part of it, but loose boards or scaffold poles merely laid across the beams of the barn, and never fastened to it, would not be, and the seller of the farm might take them away. Standing trees, of course, also pass as part of the land; so do trees blown down or cut down, and still left in the woods where they fell, but not if cut, and corded up for sale; the wood has then become personal property.

If there be any manure in the barnyard, or in the compost heap on the field, ready for immediate use, the buyer ordinarily, in the absence of any contrary agreement, takes that also as belonging to the farm, though it might not be so, if the owner had previously sold it to some other party, and had collected it together in a heap by itself, for such an act might be a technical severance from the soil, and so convert real into personal estate; and even a lessee of a farm could not take away the manure made on the place while he was in occupation. Growing crops also pass by the deed of a farm, unless they are expressly reserved; and when it is not intended to convey those, it should be so stated in the deed itself; a mere oral agreement to that effect would not be, in most States, valid in law. Another mode is to stipulate that

possession is not to be given until some future day, in which case the crops or manures may be removed before that time.

As to the buildings on the farm, though generally mentioned in the deed, it is not absolutely necessary they should be. A deed of land ordinarily carries all the buildings on it, belonging to the grantor, whether mentioned or not; and this rule includes the lumber and timber of any old building which has been taken down, or blown down, and packed away for future use on farm.

Relative Value of Different Foods for Stock.

One hundred pounds of good hay for stock are equal to:

Articles.	Pounds.	Articles.	Pounds.
Beets, white silesia	669	Lucern	89
Turnips	469	Clover, red, dry	88
Rye-Straw	429	Buckwheat	78½
Clover, Red, Green	373	Corn	62½
Carrots	371	Oats	59
Mangolds	368½	Barley	58
Potatoes, kept in pit	350	Rye	53½
Oat-Straw	347	Wheat	44½
Potatoes	360	Oil-Cake, linseed	43
Carrot leaves (tops)	135	Peas, dry	37½
Hay, English	100	Beans	28

Weights and Measures for Cooks, Etc.

1 pound of Wheat Flour is equal to	1 quart
1 pound and 2 ounces of Indian Meal make	1 quart
1 pound of Soft Butter is equal to	1 quart
1 pound and 2 ounces of Best Brown Sugar make	1 quart
1 pound and 1 ounce of Powdered White Sugar make	1 quart
1 pound of Broken Loaf Sugar is equal to	1 quart
4 Large Tablespoonfuls make	½ gill
1 Common-sized Tumbler holds	½ pint
1 Common-sized Wine-glass is equal to	½ gill
1 Tea-cup holds	1 gill
1 Large Wine-glass holds	2 ounces
1 Tablespoonful is equal to	½ ounce

Capacity of Cisterns for Each 10 Inches in Depth.

25 feet in diameter holds..3059 gallons	7 feet in diameter holds.. 239 gallons
20 feet in diameter holds..1958 gallons	6½ feet in diameter holds.. 206 gallons
15 feet in diameter holds..1101 gallons	6 feet in diameter holds.. 176 gallons
14 feet in diameter holds.. 959 gallons	5 feet in diameter holds.. 122 gallons
13 feet in diameter holds.. 827 gallons	4½ feet in diameter holds.. 99 gallons
12 feet in diameter holds.. 705 gallons	4 feet in diameter holds.. 78 gallons
11 feet in diameter holds.. 592 gallons	3 feet in diameter holds.. 44 gallons
10 feet in diameter holds.. 489 gallons	2½ feet in diameter holds.. 30 gallons
9 feet in diameter holds.. 396 gallons	2 feet in diameter holds.. 19 gallons
8 feet in diameter holds.. 313 gallons	

Surveyor's Measure.

7.92 inches 1 link, 25 links 1 rod, 4 rods 1 chain, 10 square chains or 160 square rods 1 acre, 640 acres 1 square mile.

Sizes of Boxes for Different Measures.

A box 24 inches long by 16 inches wide, and 28 inches deep, will contain a barrel, or three bushels.

A box 24 inches long by 16 inches wide, and 14 inches deep, will contain half a barrel.

A box 16 inches square and 8 2-5 inches deep, will contain one bushel.

A box 16 inches by 8 2-5 inches wide, and 8 inches deep, will contain half a bushel.

A box 8 inches by 8 2-5 inches square, and 8 inches deep, will contain one peck.

A box 8 inches by 8 inches square, and 4 1-5 inches deep, will contain one gallon.

A box 7 inches by 4 inches square, and 4 4-5 inches deep, will contain half a gallon.

A box 4 inches by 4 inches square, and 4 1-5 inches deep, will contain one quart.

A box 4 feet long, 3 feet 5 inches wide, and 2 feet 8 inches deep, will contain one ton of coal.

Strength of Ice of Different Thickness.

Two inches thick—Will support a man.

Four inches thick—Will support a man on horseback.

Five inches thick—Will support an eighty-pounder cannon.

Eight inches thick—Will support a battery of artillery, with carriages and horses.

Ten inches thick—Will support an army; an innumerable multitude.

Amount of Oil in Seeds.

Kinds of Seed	Per Cent. Oil.	Kinds of Seed.	Per Cent. Oil.
Rapeseed	55	Oats	6½
Sweet Almond	47	Clover hay	5
Turnipseed	45	Wheat bran	4
White mustard	37	Oat straw	4
Bitter almond	37	Meadow hay	3½
Hempseed	19	Wheat straw	3
Linseed	17	Wheat flour	3
Indian corn	7	Barley	2½

Results of Saving Small Amounts of Money.

The following shows how easy it is to accumulate a fortune, provided proper steps are taken. The table shows what would be the result at the end of fifty years by saving a certain amount each day and putting it at interest at the rate of six per cent:

Daily Savings.	The Result.	Daily Savings.	The Result.
One cent	$ 950	Sixty cents	$57,024
Ten cents	9,504	Seventy cents	66,528
Twenty cents	19,006	Eighty cents	76,032
Thirty cents	28,512	Ninety cents	85,537
Forty cents	38,015	One dollar	95,041
Fifty cents	47,520	Five Dollars	465,208

Nearly every person wastes enough in twenty or thirty years, which, if saved and carefully invested, would make a family quite independent; but the principle of small savings has been lost sight of in the general desire to become wealthy.

Savings Bank Compound Interest Table.

SHOWING THE AMOUNT OF $1, FROM ONE YEAR TO FIFTEEN YEARS, WITH COMPOUND INTEREST ADDED SEMI-ANNUALLY, AT DIFFERENT RATES.

	Three Per Cent.	Four Per Cent.	Five Per Cent.
One year	$1 03	$1 04	$1 05
Two years	1 06	1 08	1 10
Three years	1 09	1 12	1 15
Four years	1 12	1 17	1 21
Five years	1 16	1 21	1 28
Six years	1 19	1 26	1 34
Seven years	1 23	1 31	1 41
Eight years	1 26	1 37	1 48
Nine years	1 30	1 42	1 55
Ten years	1 34	1 48	1 63
Eleven years	1 38	1 54	1 72
Twelve years	1 42	1 60	1 80
Thirteen years	1 47	1 67	1 90
Fourteen years	1 51	1 73	1 99
Fifteen years	1 56	1 80	2 09

Time at which Money Doubles at Interest.

Rate.	Simple Interest.	Compound Interest.
Two per cent	50 years	35 years, 1 day
Two and one-half per cent	40 years	28 years, 26 days
Three per cent	33 years, 4 months	23 years, 164 days
Three and one-half per cent	28 years, 208 days	20 years, 54 days
Four per cent	25 years	17 years, 246 days
Four and one-half per cent	22 years, 81 days	15 years, 273 days
Five per cent	20 years	15 years, 75 days
Six per cent	16 years, 8 months	11 years, 327 days

ONE DOLLAR LOANED ONE HUNDRED YEARS AT COMPOUND INTEREST WOULD AMOUNT TO THE FOLLOWING SUM:

One per cent	$ 2.75	Twelve per cent	$ 84,675.00
Three per cent	19.25	Fifteen per cent	1,174,405.00
Six per cent	340.00	Eighteen per cent	15,145,207.00
Ten per cent	13,809.00	Twenty-four per cent	2,551,799,404.00

Fertilization and Cultivation of Corn and Cotton.

Bulletin of North Carolina Department of Agriculture.

By DR. B. W. KILGORE, Raleigh, N. C.

Corn

Culture.

It unquestionably pays well to thoroughly break and broadcast harrow land for corn. Using a two-horse plow and running it 8 to 10 inches deep, and afterwards harrowing with large smoothing harrow, puts the land in nice condition. It is also well to run a small-tooth harrow across corn rows about the time the plants are coming up, and even after they are several inches high, slanting the teeth of the harrow backward. Harrowing in this way saves after-cultivation, and is a quick way of getting over the land. The land being thoroughly broken before the corn is put in the ground, only shallow, level cultivation with some one of the considerable number of good cultivators need be given during the growing season. The one-horse cultivators cover corn rows in two to three furrows, and the two-horse ones at a single trip. The cultivation should be frequent—about every ten days—and if possible just after rains, so as to break any crust formed by showers, leaving a dust mulch to retard the loss of moisture added to the soil in the previous rains. Toward the end of the growing season the cultivators should only be run one to one and a half inches deep, so as to disturb as little as possible the roots of the plants, which, by that time, are well into the middle of the rows.

Fertilizers for Corn.

The experimental work on the sandy soils of the east, reports of which have been made previously, has progressed far enough, we feel, to draw some conclusions in reference to the best amounts and proportions of nitrogen, phosphoric acid and potash for corn. As the results of the past two years' work have not yet been published, the following formulas, based on the result of the first two years' tests and tests in other

States with similar soil and climatic conditions, are given as good ones for corn:

For Corn on Land in Fair Condition.

Acid phosphate, 14 per cent. phosphoric acid.........	1,045 lbs.
Cotton-seed meal, 6.59 per cent. nitrogen, 2.5 phosphoric acid and 1.5 potash........................	520 lbs.
Nitrate of Soda, 15 per cent. nitrogen...............	225 lbs.
Kainit, 12.5 per cent. potash........................	210 lbs.
	2,000 lbs.

In this formula one-half of the nitrogen is supplied by nitrate of soda and the other one-half by cotton-seed meal. This mixture will contain: available phosphoric acid, 8.0 per cent.; potash, 1.7 per cent.; nitrogen, 3.4 per cent. (equal to ammonia, 4.0 per cent.).

Acid phosphate, 14 per cent. phosphoric acid.........	965 lbs.
Cotton-seed meal, 6.59 per cent. nitrogen, 2.5 phosphoric acid and 1.5 potash........................	750 lbs.
Nitrate of Soda, 15 per cent. nitrogen...............	110 lbs.
Kainit, 12.5 per cent. potash........................	175 lbs.
	2,000 lbs.

In this formula one-fourth of the nitrogen is supplied by nitrate of soda and the other three-fourths by cotton-seed meal. This mixture will contain: available phosphoric acid, 7.7 per cent.; potash, 1.7 per cent.; nitrogen, 3.3 per cent. (equal to ammonia, 4.0 per cent.).

Nitrate of Soda. This material is quick-acting because of its easy solubility in water. For this reason when used in a considerable quantity in fertilizers at time of planting on light sandy land, there is danger of its being leached beyond the reach of the roots of the plants before they can use it. On clay lands and loams having good subsoils, to them this danger does not exist, certainly not to the extent that it does on light soils. A small amount of nitrate of soda in the mixture will give the crop a quick start and make its cultivation easier and more economical. On light lands it would likely be better to omit the nitrate from the mixture and apply it as a top dressing between the tenth and last of June on early corn. Nitrate of soda may take the place of a portion of the other nitrogen-furnishing materials in any of the formulas, one pound of nitrate being equal in its content of nitrogen to 2.2 pounds cotton-seed meal, 2 pounds fish scrap, 1.2 pounds dried

blood. Nitrate of soda is frequently used as a top dressing for corn and is a valuable material for use in this way. A good application is 50 to 75 pounds per acre, distributed along the side of the row or dropped beside the plants and three or four inches from them, or else where there is a ridge in the centre it may be distributed on this and when it is thrown out the nitrate will be thrown to the two sides of the row.

Application of Fertilizers to Corn.

On clay lands and loams having good subsoil the fertilizer should be applied in the drill, at or just before planting, at the rate of two to four hundred pounds per acre. On light sandy lands it is best to use 50 to 100 pounds (of nitrate) in the drill at time of planting, to give the crop a good start, and the balance of the fertilizer as a side-dressing when the corn has begun to grow well.

Cotton.

Culture.

The remarks regarding the preparation and cultivation of corn also apply with equal force to cotton, unless it be the part regarding breaking the land well before planting. Some doubt the necessity of this for cotton. Cotton is generally grown on ridges. This is necessary on wet soils, but on all fairly well-drained upland and sandy soils we are convinced that level and frequent shallow cultivation, as was indicated for corn, is the best and most economical method to follow in growing cotton. Ridge culture may give better results in very wet years, but taking the seasons as they come the advantage will lie, we think, with flat culture.

Fertilizers for Cotton.

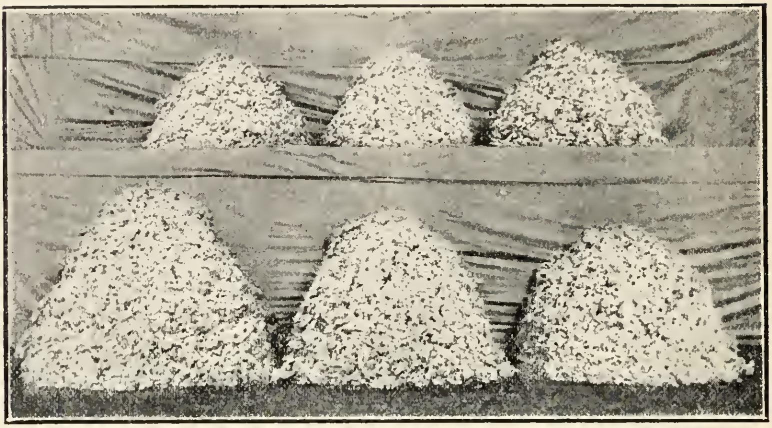
The preliminary remarks regarding fertilizers for corn also apply to cotton, the following formulas being offered tentatively and as the result of our best judgment, after studying the best obtainable data on the subject:

For Cotton on Land in Fair Condition.

Acid phosphate, 14 per cent. phosphoric acid.........	1,015 lbs.
Cotton-seed meal, 6.59 per cent. nitrogen, 2.5 phosphoric acid and 1.5 potash......................	415 lbs.
Nitrate of soda, 15 per cent. nitrogen...............	180 lbs.
Kainit, 12.5 per cent. potash..........................	390 lbs.
	2,000 lbs.

Brown Cotton.

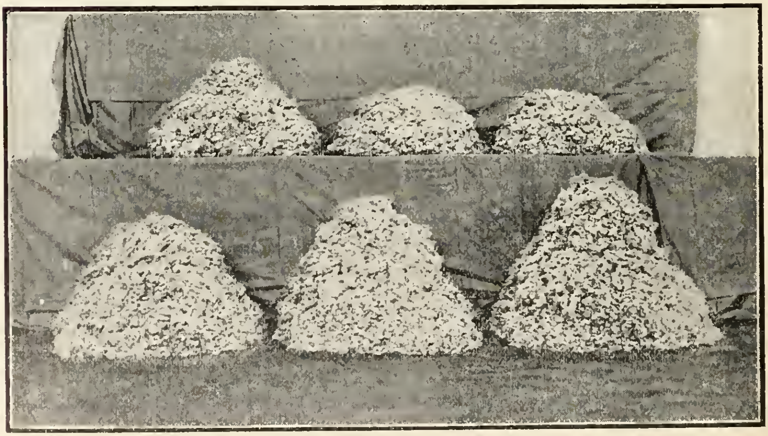
Without Manure. | 4 Cwt. Kainit. | 12 Tons Farm-Yard Manure.



4 Cwt. Superphosphate. 2 Cwt. Nitrate of Soda. | 2 Tons of Poudrette. | 5 Cwt. Superphosphate.

Abbasi White Cotton, Lower Egypt.

12 Tons Yard Manure. | 4 Cwt. Kainit. | Without Manure.



5 Cwt. Superphosphate. | 2 Cwt. Nitrate of Soda. | 4 Cwt. Superphosphate. 2 Cwt. Nitrate of Soda.

Results on Cotton Grown in Lower Egypt.

In this formula one-half of the nitrogen is supplied by nitrate of soda and the other one-half by cotton-seed meal. This mixture will contain: available phosphoric acid, 7.6 per cent.; potash, 2.7 per cent.; nitrogen, 2.7 per cent. (equal to ammonia, 3.3 per cent.).

Acid phosphate, 14 per cent. phosphoric acid.........	955 lbs.
Cotton-seed meal, 6.59 per cent. nitrogen, 2.5 phosphoric acid and 1.5 potash......................	605 lbs.
Nitrate of soda, 15 per cent. nitrogen...............	90 lbs.
Kainit, 12.5 per cent. potash......................	350 lbs.
	2,000 lbs.

In this formula one-fourth of the nitrogen is supplied by nitrate of soda and the other three-fourths by cotton-seed meal. This mixture will contain: available phosphoric acid, 7.4 per cent.; potash, 2.6 per cent.; nitrogen, 2.6 per cent. (equal to ammonia, 3.1 per cent.).

Cotton Seed and Nitrate of Soda.

The remarks under corn regarding these two materials apply also to cotton, as do the suggestions concerning the change in the quantity of nitrogen-supplying materials in the formulas, should cotton follow peas or any other leguminous crop. In Formula No. 3 one-fourth of the Nitrogen is supplied by Nitrate of Soda, with the view of giving the crop a quick start, and in No. 2 one-half of the Nitrogen comes from this source. On light lands it will be good practice to omit this Nitrate from the mixture and apply it as a side-dressing about the middle of June. Good results come from the use of it in this way on heavy types of land. Where land does not produce a good stalk of cotton, and fertilizers are used which contain only a moderate amount of nitrogen, or ammonia, good results are obtained from a side-dressing of 50 to 100 pounds of nitrate of soda per acre. The nitrate should be distributed along one side of the row, or where there is a ridge in the middle it may be put on this and when the ridge is thrown out the nitrate will be thrown on two sides of the row.

Application of Fertilizer to Cotton.

The fertilizer should be applied in the drill at or just before planting. The quantity used for cotton varies from 200 to 1,000 pounds per acre.

Fertilizers for Tobacco.

There are few products whose quality and quantity are more affected by kind of soil and fertilizer than is tobacco. For bright tobacco, the main kind grown in this State, the fine and deep sandy loam with yellow-colored sandy clay subsoil is the type of land most largely used and the one which grows the best grade of this character of tobacco. Generally, the kind of soil that is suited to the production of tobacco is better understood than the fertilizer that should be used on it. Evidence of this is seen in the great variation in the composition of fertilizers sold in the State, especially for use on the tobacco crop. In 1901 there were registered with the Department of Agriculture one hundred and eight (108) special fertilizers for tobacco. It is interesting in this connection to note the wide variation as well as the average composition of these fertilizers. The highest amount of available phosphoric acid guaranteed in any of them was 9.25 per cent., the lowest, 5 per cent., and the average 8.12 per cent. The highest amount of ammonia guaranteed was 10 per cent., the lowest 2 per cent., and the average 2.73 per cent. The highest amount of potash guaranteed was 5 per cent., the lowest 1 per cent., and the average 2.64 per cent. These wide variations in the amounts of the valuable fertilizer constituents indicate that the fertilizers themselves must have had very varying effects on the quality and quantity of the tobacco crop.

A study of the experiments in tobacco-growing and a consideration of the experiences of good tobacco growers show that the amounts of ammonia and potash in the average tobacco fertilizers, as stated above, are not as large as are needed to give the best results. It would appear that the largest amount of ammonia (10 per cent.) in any of these "specials" is greater than is required for bright tobacco, while the maximum quantity of potash (5 per cent.) in any of the 108 brands is less than is used by numbers of our best bright tobacco growers, especially in the eastern part of the State. A considerable number of these growers either mix their own tobacco fertilizers, or else have them put up according to formulas of their suggestion. Below are given five formulas for mixing fertilizers for tobacco. The grade of those fertilizers will be higher and they will, of course,

cost more than the goods that are generally used in the State on tobacco, but I feel confident that the increased yield will more than justify the additional expense. In *The Bulletin* of the Department of Agriculture and in our correspondence with farmers we have been recommending formulas of about the composition of these for a number of years, and evidence is accumulating which shows that the character of tobacco fertilizers is undergoing quite a considerable change.

No. 1—

Cotton-seed meal	900 lbs.
Nitrate of soda	100 lbs.
High-grade sulphate of potash	250 lbs.
Acid phosphate, 14 per cent	750 lbs.
	2,000 lbs.

This mixture will contain: available phosphoric acid, 6.3 per cent.; potash, 6.9 per cent.; nitrogen, 3.7 per cent. (equal to ammonia, 4.5 per cent.).

No. 2—

High-grade dried blood	500 lbs.
Nitrate of soda	125 lbs.
High-grade sulphate of potash	310 lbs.
Acid phosphate	1,065 lbs.
	2,000 lbs.

This mixture will contain: available phosphoric acid, 7.4 per cent.; potash, 7.7 per cent.; nitrogen, 4.3 per cent. (equal to ammonia, 5.2 per cent.).

No. 3—

Fish scrap	725 lbs.
Nitrate of soda	100 lbs.
High-grade sulphate of potash	300 lbs.
Acid phosphate	875 lbs.
	2,000 lbs.

This mixture will contain: available phosphoric acid, 7.2 per cent.; potash, 7.5 per cent.; nitrogen, 3.8 per cent. (equal to ammonia, 4.6 per cent.).

No. 4—

Dried blood	500 lbs.
Nitrate of soda	100 lbs.
High-grade sulphate of potash	400 lbs.
Acid phosphate	1,000 lbs.
	2,000 lbs.

This mixture will contain: available phosphoric acid, 7 per cent.; potash, 10 per cent.; nitrogen, 4.1 per cent. (equal to ammonia, 5 per cent.).

No. 5—

Cotton-seed meal	700 lbs.
Nitrate of soda	100 lbs.
High-grade sulphate of potash	300 lbs.
Acid phosphate	900 lbs.
	2,000 lbs.

This mixture will contain: available phosphoric acid, 7.2 per cent.; potash, 7.7 per cent.; nitrogen, 3.1 per cent. (equal to ammonia, 3.8 per cent.).

Four hundred to one thousand pounds of these mixtures should be used to the acre.

The mixtures made from formulas Nos. 2 and 3 are somewhat more concentrated than that from No. 1, on account of cotton-seed meal containing less ammonia than fish scrap and dried blood. The three formulas are given to enable the use of any one of the three main organic, nitrogenous materials—dried blood, fish scrap and cotton-seed meal. In the coast sections, fish scrap and meal are both easily obtained; some distance inland meal is more accessible, while in the more western end of the tobacco belt it will be found convenient to use dried blood. All three are good sources of ammonia for tobacco. The other materials—nitrate of soda, sulphate of potash and acid phosphate—are the same for all mixtures.

Occasional requests are made for formulas furnishing as much as 10 per cent. of potash, and No. 4 has been arranged to meet needs of this nature. It is known that excellent tobacco, in quality and quantity is grown by the use of fertilizers of this class, and some of our farmers greatly prefer them to others containing less potash. It takes considerable observation and experimentation to determine the best practice in matters of this kind.

A limited quantity of stable manure is very beneficial to tobacco and it succeeds well after peanuts. These materials add ammonia to the soil, and where heavy applications of fertilizers are to be made in connection with manure, and on peanut land, it would be well not to have so much ammonia in the fertilizers as is used in the ones employed on land not having other ammonia materials put on them. Formula

No. 5 is destined to meet cases of this kind. A good many Eastern tobacco growers plant tobacco after peanuts, and some of them grow peas between the hills of tobacco, planting them with hoes and putting six to ten peas in a place the latter part of June or early in July. This improves the soil for after-crops, but tobacco grown after tobacco and peas is said not to be of good quality; though, as would be expected, the growth is very large.

Good results will come from the use of high grade fertilizers, such as are suggested above, or similar ones, and we believe that when once tried there will be no inclination to go back to the lower grade ones now so largely used.

Fertilizing Hay Crops.

The experiments with fertilizers on hay crops, begun in 1901, were continued during the season of 1902-3. During the season of 1901-2 it was found that the use of Thomas phosphate slag and sulphate of potash with Nitrate of Soda did not pay as we'l as Nitrate of Soda used alone. The experiments during the last season were planned to test the availability of the phosphate after the first season. It was thought last year that there was a possibility that the insoluble slag phosphate would become more available the second season after applying it. The plots used in the 1901-2 experiments were subdivided and given different applications of Nitrate of Soda used alone and in combination with sulphate of potash used at the rate of 300 pounds per acre.

The yield of hay was lower on both fertilized and unfertilized plots during the season of 1902-3 than it was in 1901-2. This difference is undoubtedly due to an unfavorable season. The late spring rainfall failed almost entirely, and to this no doubt must be attributed the decreased yield.

An inspection of the summary of results tabulated below shows that the heaviest yields of hay on both red and

granite soils and the largest money returns per acre were obtained from the plots which were fertilized with phosphate during 1901-2. On red soil with oats the gain from the use of Nitrate of Soda on the plot which had phosphate the year previous was $11.70 per acre, as against only $3.72 per acre where the nitrate was used on land having no previous fertilization.

On granite soil with oats, there was no gain from the phosphate. The use of Nitrate of Soda alone without previous fertilization yielded $9.44 per acre profit, while on the plots having phosphate applied the previous year, the gain was only $5.74 per acre.

The heaviest yield of hay and the largest profit per acre in 1903 were obtained with wheat on granite soil which had an application of Thomas slag, sulphate of potash, and lime in 1902. Nitrate of Soda was used at the rate of 320 pounds per acre in 1903. The yield of hay was 5,772 pounds per acre, and the resulting profit $12.89 per acre. It should be remarked here, however, that this plot was fertilized at a loss of $21.50 per acre in 1902; and as the application of nitrate was larger than was used on any other plot, the increased returns were at least partly due to the increased supply of the nitrate. Through some misunderstanding, there was no no corresponding wheat plot on granite soil with nitrate only.

The use of sulphate of potash in combination with Nitrate of Soda, on granite soil, did not pay in 1903. Potash was used at the rate of 300 pounds per acre. In most cases the fertilizer cost more than the increased crop of hay; hence its use incurred a loss of from 76 cents to $4.57 per acre.

The experiments with Nitrate of Soda used alone were broadened in 1903 to test the efficacy of different amounts per acre and the division of the application into two doses. The results show that in 1903, 160 pounds of Nitrate of Soda per acre in one application yielded the largest profits, viz.: $9.44 and $8.90 per acre, respectively, on two plots on granite soil. In all cases the yield was reduced when the fertilizer was put on in two applications; thus, with 160 pounds per acre applied in two doses, only $4.82 and $7.27 per acre were yielded by two plots on granite soil.

RHODE ISLAND EXPERIMENT STATION.

What Percentage of Water Does Hay Lose During Storage?

Hay which had been stored during the summer of 1901 was removed from the mow the following February, and found to contain 12.21 per cent. of water. A careful comparison of other moisture determinations of hay leads to the conclusion that 12.21 is a fair general average of the percentage of water in the best quality of barn-cured hay.

RESULTS IN NEW YORK.

The general practice among farmers is to buy complete medium or low-grade fertilizers in preference to high-grade fertilizers. In high-grade goods, the cost of plant-food is considerably less than in fertilizers of lower grade.

Available phosphoric acid is cheapest in the form of dissolved rock (acid phosphate). Bone-meal furnishes a cheap source of phosphoric acid in less available form. Nitrate of Soda is one of the cheapest sources of Nitrogen, while bone is another. Nitrogen in the form of dried blood is rather high. Potash in the form of muriate is the cheapest source of potash. In mixtures of fertilizing materials, whether complete or incomplete, the plant-food usually costs more than in unmixed materials.

When purchasing mixed fertilizers, farmers are advised to purchase only high-grade goods, and then to make a commercial valuation to compare with the selling price. *Even in high-grade goods, the selling price should not exceed the commercial valuation by more than $5.*

For greatest economy, farmers are advised to purchase unmixed materials and do their own mixing; or, in the case of clubs, several farmers can purchase their unmixed materials and hire a fertilizer manufacturer to do the mixing for them.

The following data, taken from the last U. S. Census Report, are of interest in this connection as indicating in what portions of the State the largest amount of money is expended for commercial fertilizers:

Long Island (Counties of Nassau, Queens and Suffolk)........	$1,241,280
Monroe County..	214,000
Erie County..	186,370
Cayuga County..	131,260
Oneida County..	112,630
Onondaga, Ontario, Wayne, Ulster, Chautauqua, each from $102,000 to..	110,000

These twelve counties use about one-half of the commercial fertilizers used in the entire State.

Composition of Fertilizers in Different Classes.

If we compare our four different classes of complete fertilizers in respect to the average amounts of Nitrogen, available phosphoric acid and potash contained in them, we have the following table:

Composition of Different Grades of Fertilizers.

Class of Fertilizers.	In 100 Pounds of Fertilizer.			
	Pounds of Nitrogen.	Pounds of Available Phosphoric Acid.	Pounds of Potash.	Pounds of Total Plant-food.
Low-grade..................	1.22	8.18	2.60	12.00
Medium-grade................	1.70	9.10	3.48	14.28
Medium high-grade...........	2.47	8.82	6.02	17.37
High-grade..................	4.00	8.36	7.22	19.60

In the fourth column, under the heading "pounds of total plant-food," we give the sum of the Nitrogen, available phosphoric acid and potash. We notice the following points in connection with this table:

1. The percentage of phosphoric acid does not vary greatly in the different classes of fertilizers.

2. The percentage of Nitrogen and of potash increases in the higher grades.

3. The total amount of plant-food in 100 pounds of fertilizer increases in the higher grades, this increase being due to increase of Nitrogen and potash.

4. Representing the amount of Nitrogen in each grade of fertilizer as 1, we have the following proportions of available phosphoric acid and potash in the different grades:

Composition of Different Grades of Fertilizers.

	Nitrogen.	Available Phosphoric Acid.	Potash.
Low-grade	1	7	2
Medium-grade	1	5.5	2
Medium high-grade	1	3.5	2.5
High-grade	1	2	1.8

Cost of One Pound of Plant-Food in Different Grades of Fertilizers.

	Low Grade.	Medium Grade.	Medium High-Grade.	High Grade
Cost of one pound of Nitrogen.	*Cents.*	*Cents.*	*Cents.*	*Cents.*
Lowest	20	17.9	17	13.3
Highest	36.8	28.3	26	26.0
Average	26.3	23.2	21	19.6
Cost of one pound of Available Phosphoric Acid.				
Lowest	6.1	5.4	5.1	4.25
Highest	11.1	8.6	8.1	7.9
Average	8.0	7.0	6.4	6.0
Cost of one pound of Potash.				
Lowest	5.2	4.6	4.4	3.4
Highest	9.5	7.3	6.9	6.7
Average	6.8	6.0	5.4	5.0

From these data, we readily see the truth of the following statements:

1. The cost of one pound of plant-food, whether Nitrogen, phosphoric acid or potash, is greatest in low-grade, and least in high-grade, fertilizers. One purchaser of low-grade goods paid 36.8 cents a pound for Nitrogen, while the highest price paid in high-grade goods was 26 cents, which is less than the average paid for Nitrogen in low-grade goods. The least amount paid for one pound of Nitrogen in low-grade goods was 20 cents, in high-grade goods 13.3 cents. Similar relations hold good in respect to the other elements of plant-food.

2. In general, the higher the grade of goods, the lower the cost of each pound of plant-food.

Cost of Nitrogen in Nitrate of Soda.

In the samples of Nitrate of Soda examined by us in 1902, the percentage of Nitrogen varied from 15.21 to 16.20, averaging 15.77. The selling price varied from $42 to $48.50, averaging $44.12. The commercial valuation varied from $45.63 to $48.60, averaging $47.30, which was considerably in excess of selling price. The cost of one pound of Nitrogen in this form varied from 13 to 15 cents and averaged 13.9 cents. This was much cheaper than the cost of Nitrogen in the form of complete fertilizers.

Tabulated General Summary.

In the table following, we give a general summary of the data that have been presented, showing the cost of one pound of plant-food in different forms to consumers:

Cost of One Pound of Plant-Food to Consumers.

	Lowest	Highest.	Average.
NITROGEN IN	*Cents.*	*Cents.*	*Cents.*
Low-grade complete fertilizers...........	20	36.8	26.3
Medium-grade complete fertilizers........	17.9	28.3	23.2
Medium high-grade complete fertilizers...	17	26	21
High-grade complete fertilizers	13.3	26	19.6
Dried blood	14.8	22.9	18.5
Bone-meal	11.5	32	14.9
Nitrate of Soda......................	13	15	13.9
PHOSPHORIC ACID IN			
Low-grade complete fertilizers...........	6.1	11.1	8.0
Medium-grade complete fertilizers........	5.4	8.6	7.0
Medium high-grade complete fertilizers...	5.1	8.1	6.4
High-grade complete fertilizers...........	4.25	7.9	6.0
Phosphoric acid and potash mixtures.....	4.3	19.5	6.6
Acid phosphate or dissolved rock.........	4.4	11.0	5.1
Bone (total).........................	3.1	8.6	3.96
POTASH IN			
Low-grade complete fertilizers...........	5.2	9.5	6.8
Medium-grade complete fertilizers........	4.6	7.3	6.0
Medium high-grade complete fertilizers...	4.4	6.9	5.4
High-grade complete fertilizers...........	3.4	6.7	5.0
Phosphoric acid and potash mixtures.....	3.7	16.5	5.6
Muriate of potash	4.4	4.9	4.6

Plants can take up Nitrogen only in the form of *Nitrates*—that is, in combination with alkaline base, such as lime or sodium.

The Nitrogen contained in all fertilizers, with the exception of *Nitrate of Soda*, must first be nitrified—that is, converted into Nitrate—before the plant can take it up. This nitrification is always attended with greater or less loss of Nitrogen.

A sufficiency of lime in the soil hastens nitrification, while a scarcity of lime retards it. *Nitrate of Soda* is the only nitrogenous fertilizer that will do its work perfectly without lime, because it already contains Nitrogen in a form that is capable of absorption by plants.

Leguminous plants assimilate free Nitrogen from the air through the medium of the micro-organisms inhabiting the nodules found in their roots. Leguminous plants, in the early stages of their growth, avail themselves of the Nitrates in the soil. *Nitrate of Soda* has been very profitably used in the cultivation of Lucern, or "Alfalfa," etc.

Crops that have suffered from wintering, from insects, etc., can, in most cases, be considerably improved by top-dressing with *Nitrate of Soda.*

When the soil is very poor in potash, the soda contained in *Nitrate of Soda* will, to a certain extent, serve as a substitute for potash. It is not, however, a perfect substitute. Poverty in potash can be fully made good only by applying a sufficient quantity of a potash fertilizer.

Nitrate of Soda is easily soluble, and it distributes itself immediately through the soil.

Distribution of Nitrogen in the Grain and Straw of the Principal Cereals.

NITROGEN PER TWO AND ONE-HALF ACRES.

GRAIN.

Oats,	Barley,	Wheat,	Rye,
82.42 lbs.	86.61 lbs.	81.10 lbs.	67.44 lbs.
Rape Seed,	Peas,	Vetches,	Broad Beans,
176.32 lbs.	117.03 lbs.	143.92 lbs.	181.16 lbs.

STRAW.

Oats,	Barley,	Wheat,	Rye,
26.4 lbs.	26.4 lbs.	33.06 lbs.	29.31 lbs.
Rape Seed;	Peas,	Vetches,	Broad Beans,
29.75 lbs.	118.35 lbs.	112.40 lbs.	79.34 lbs.

Distribution of Nitrogen in the Principal Root Crops.

NITROGEN PER TWO AND ONE-HALF ACRES.

ROOTS.

Sugarbeet,	Beetroot,	Swedes,	Carrots,	Potatoes,
105.79 lbs.	138.85 lbs.	165.30 lbs.	145.46 lbs.	112.40 lbs.
				TUBERS.

LEAF.

Sugarbeet,	Beetroot,	Swedes,	Carrots,	Potatoes,
52.89 lbs.	80.66 lbs.	55.1 lbs.	168.60 lbs.	15.11 lbs.
				SHAWS.

The figures in this table show how many pounds of Nitrogen are withdrawn from two and one-half acres of ground by an average harvest. The table shows clearly that the principal quantity of Nitrogen is always in that portion of the crop that is sold, only a small quantity of Nitrogen being found in the straw and leaves, the portion that is retained for use upon the land; consequently, unless a sufficient quantity of nitrogenous fertilizers be applied, the soil will very soon suffer from impoverishment of Nitrogen.

POINTS FOR CONSIDERATION AS TO PRICES OF FARM PRODUCTS AND NITRATE PRICES.

"FROM the farmer's point of view, a reduction in cotton and produce prices is to be deplored, but the point to be considered is whether abstention from the use of Nitrate is a wise way of meeting the situation. The utility of a fertilizer obviously depends upon its productivity, and as its productivity is not affected by its price, an increase in the latter justifies abandonment of the fertilizer only when its productivity ceases to be profitable. The profit to be reasonably expected from the use of fertilizer, although somewhat less than when it was cheaper, is not so materially interfered with by any rise in price of Nitrate as to economically justify any substantial reduction in its consumption."

GRADES OF HAY AND STRAW.

THE following are the rules and regulations adopted by the Chicago Board of Trade for the inspection of hay and straw:

Choice Timothy Hay: Shall be timothy not mixed with over one-twentieth of other grasses, properly cured, bright, natural color, sound and well baled.

No. 1 Timothy Hay: Shall be timothy mixed with not more than one-eighth clover, red-top, and other tame grasses, properly cured, good color, sound and well baled.

No. 2 Timothy Hay: Shall include all timothy not good enough for No. 1, not over one-third mixed with other tame grasses, fair color, sound and well baled.

No. 3 Timothy Hay: Shall include all hay not good enough for other grades, sound and well baled.

No. 1 Clover Mixed Hay: Shall be timothy and clover mixed, with at least one-half timothy, good color, sound and well baled.

No. 2 Clover Mixed Hay: Shall be timothy and clover mixed, with at least one-third timothy, reasonably sound and well baled.

No. 1 Clover Hay: Shall be medium clover, not over one-twentieth other grasses, properly cured, sound and well baled.

No. 2 Clover Hay: Shall be clover, sound, well baled, not good enough for No. 1.

No Grade Hay: Shall include threshed timothy and all hay badly cured, musty, stained, or in any way unsound.

Choice Prairie Hay: Shall be upland hay, of bright color, well cured, sweet, sound and reasonably free from weeds.

No. 1 Prairie Hay: Shall be upland, and may contain one-quarter midland, of good color, well cured, sweet, sound and reasonably free from weeds.

No 2 Prairie Hay: Shall be upland of fair color or midland of good color, well cured, sweet, sound and reasonably free from weeds.

No. 3 Prairie Hay: Shall be midland of fair color or slough of good color, well cured, sound and reasonably free from weeds.

No. 4 Prairie Hay: Shall include all hay not good enough for other grades and not caked.

No grade Prairie Hay: Shall include all hay not good enough for other grades.

No. 1 Straight Rye Straw: Shall be in large bales, clean, bright, long rye straw, pressed in bundles, sound and well baled.

No. 2 Straight Rye Straw: Shall be in large bales, long rye straw, pressed in bundles, sound and well baled, not good enough for No. 1.

Tangled Rye Straw: Shall be reasonably clean rye straw, good color, sound and well baled.

Wheat Straw: Shall be reasonably clean wheat straw, sound and well baled.

Oat Straw: Shall be reasonably clean oat straw, sound and well baled.

All certificates of inspection shall show the number of bales and grade in each car or lot inspected and plugged; and when for shipment the final inspection and plugging, in order to ascertain the sound condition of each bale, shall take place at the time of shipment.

The fees for inspection shall be $3.00 per car, to be divided equally between the buyer and seller.

GENERAL DIRECTIONS FOR STAPLE CROPS.

THE use of Nitrate of Soda *alone* is never recommended, except at the rate of not more than one hundred pounds to the acre. *It may be thus safely and profitably used without other fertilizers.* It may be applied at this rate as a Top-Dressing in the Spring of the year, as soon as vegetation begins to turn green; or, in other words, as soon as the crops begin new growth. At this rate very satisfactory results are usually obtained without the use of any other fertilizer, and the Soda residual, after the Nitrogenous Ammoniate Food of this chemical is used up by the plant, has a perceptible effect in sweetening sour land.

When it is desired to use a larger amount than one hundred pounds per acre of Nitrate of Soda as a Top-Dressing, or in any other way, there must be present some form of Phosphatic and Potassic Fertilizer, and we recommend not less than two hundred and fifty pounds of either

Acid Phosphate; or Thomas Phosphate; or fine ground Raw Rock; or Peruvian Guano; and two hundred and fifty pounds of some high-grade Potash Salt, preferably the Sulphate. *A much larger amount than one hundred pounds of Nitrate per acre, when used alone on staple crops, is generally sure to give an unprofitable and unbalanced food ration to the plant.* For Market Gardening Crops, however, somewhat more may be used alone. When the above amounts of Phosphatic and Potassic Fertilizers are used, as much as three hundred pounds of Nitrate of Soda may be applied with profit. In applying Nitrate in any ration it is desirable to mix it with an equal quantity of land plaster or fine, dry loam or sand.

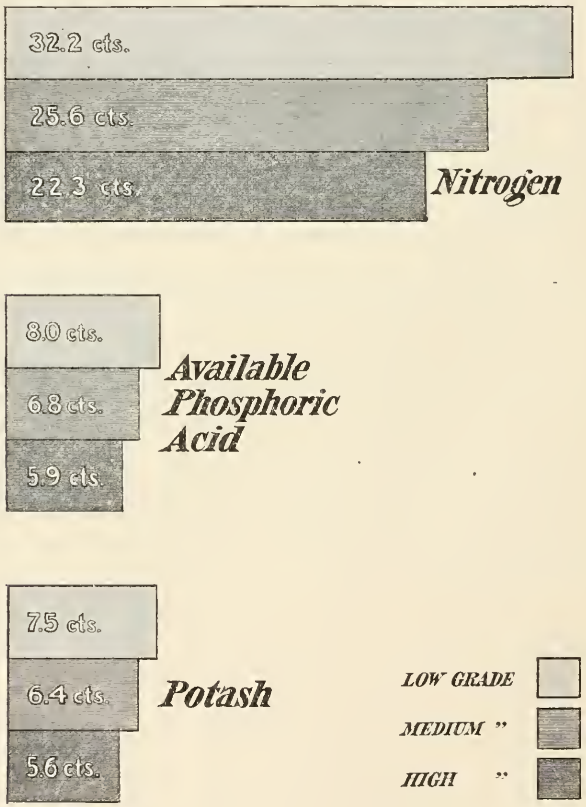
Generally, on the Pacific Coast, nitrate may be applied as a top-dressing after the heavy spring rains are over, but before crops attain much of a start.

The statement fraudulently made that Nitrate of Soda is a stimulant, is false and misleading, as the Nitrogen (which is the essential element for the growth of all plants) is the same in Nitrate of Soda as it is in stable manure, and has the additional advantage that it is thirty times as abundant and of a hundred-fold greater immediate availability. Its after effect is also marked in subsequent seasons, owing to the energy and increased size and feeding capacity which it imparts to the roots of plants. It also has a sweetening influence on sour lands, and hence is of direct as well as indirect benefit to the land. As a healthy plant tonic it has no equal, and owing to its complete digestibility as a plant-food there is absolutely no roughage or raw matter in it.

FERTILIZERS.

Contributed by J. L. Hills, Vermont Experiment Station.

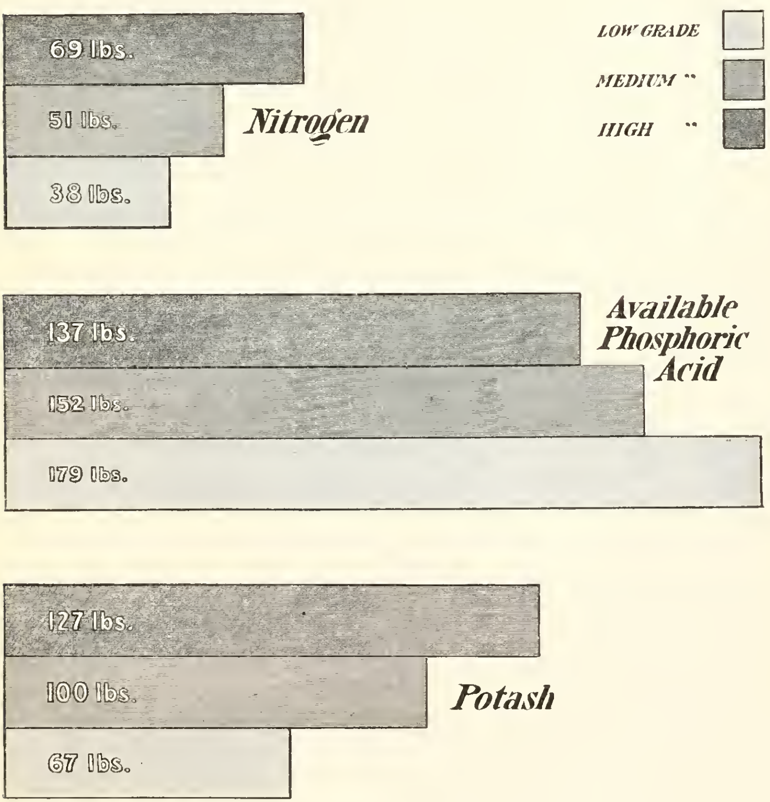
Average cost of a pound of plant food in low, medium and high grade (Vermont, 1903.)



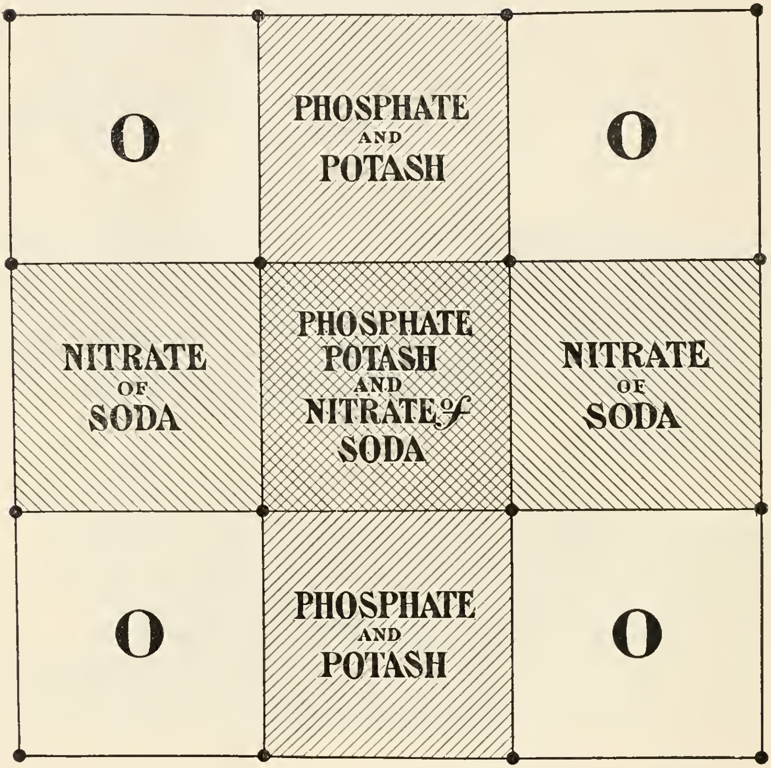
FERTILIZERS.

Contributed by J. L. Hills, Vermont Experiment Station.

For $30 there was purchased in Vermont, in 1903, in average high grade, medium grade and low grade fertilizers the following amounts of actual plant foods:



PLAN FOR TOP-DRESSING EXPERIMENTS.



The above simple plan for Top-Dressing Experiments has been in satisfactory use in Europe for several years. The plots may be of any size from a square 20 feet x 20 feet, and upwards. The squares marked O are not fertilized, and serve as check plots. The Nitrate application recommended for a square 20 feet x 20 feet is one pound, which is equivalent to one hundred pounds to the acre. For further details, see General Directions for Staple Crops.

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